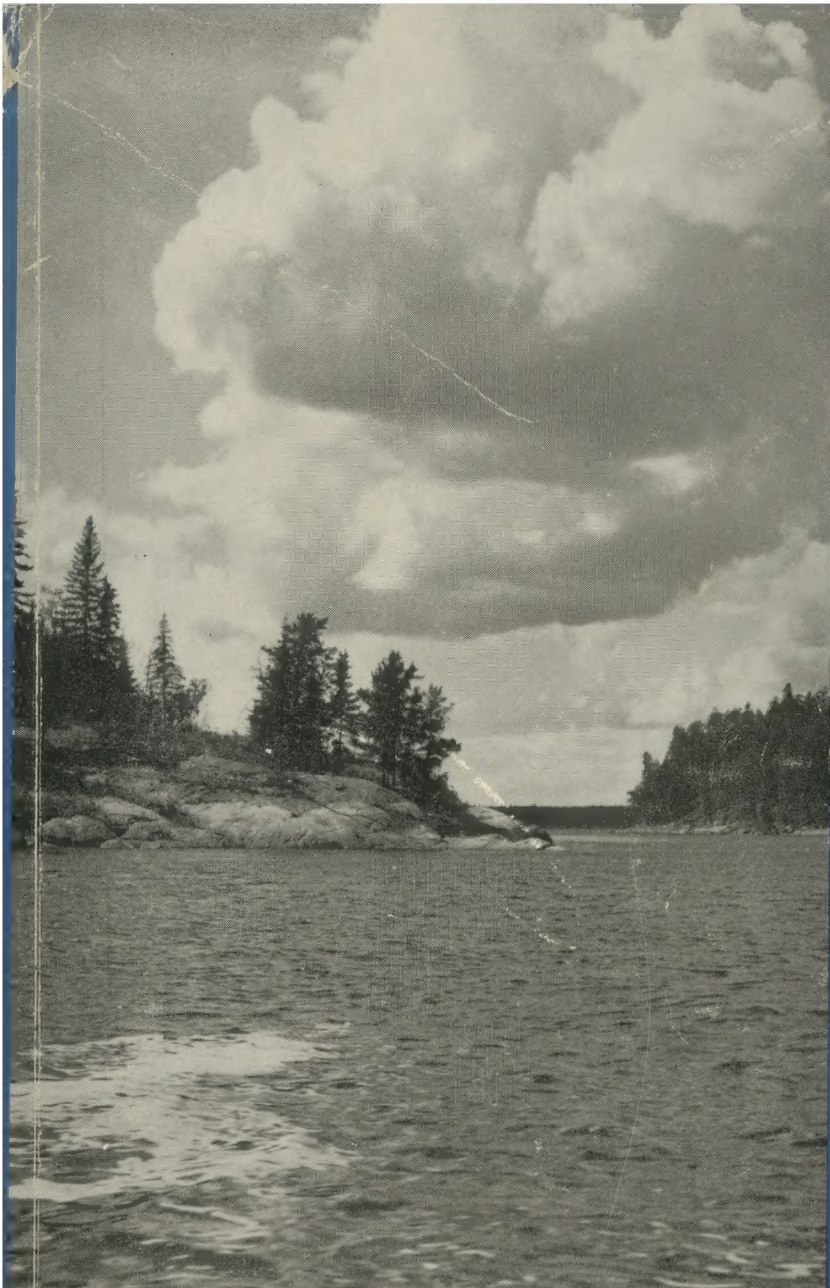

A Guide for PROSPECTORS in Manitoba

Fourth Edition, 1952

A GUIDE FOR PROSPECTORS IN MANITOBA

1952

Published by authority of the Hon. J. S. McDiarmid
Minister of Mines and Natural Resources

Address all inquiries to
DIRECTOR OF MINES
Department of Mines and Natural Resources
Winnipeg, Manitoba

WINNIPEG
1952

Printed by C. E. LEECH
Printer to the King's Most Excellent Majesty

FOREWORD

THE extension of prospecting activity for minerals in Manitoba so emphasized the need for placing in the hands of the prospector more detailed information of the geology of our extensive mineral areas that "A Guide for Prospectors in Manitoba" was prepared by the Mines Branch.

This booklet was received with widespread interest and has passed through three editions, the first in 1936, the second in 1937, and the third in 1945.

In producing those editions reports on all geological investigations made in the Province, many of them now out of print, were reviewed. Information was collected and condensed into convenient form. In the past six years much new information with respect to our mineral resources has been gained, so that another edition is warranted.

It is believed that this fourth edition of "A Guide for Prospectors in Manitoba" will continue to be of practical help to seasoned prospectors and an inspiration to those who have not experienced the thrill of original discovery.

May they all share in that prosperity which the development of mining will bring to Manitoba.

December, 1951.

NOTE

The first and second editions of this Guide were prepared by A. J. McLaren and F. D. Shepherd, at the time Inspector of Mines and Provincial Geologist, respectively.

The third edition was prepared by I. H. Spector, at the time Geologist for the Mines Branch.

The present edition was prepared by J. D. Allan, Chief Geologist, G. C. Milligan, Geologist, and G. D. Springer, Geologist of the Mines Branch.

Since the publication of the third edition, the Geological Survey of Canada, and the Manitoba Mines Branch have issued numerous reports on various parts of Manitoba. These as well as all earlier reports were reviewed in preparing this edition, and information contained in them has been drawn upon freely and is hereby acknowledged. The sources of this information are given at the end of each chapter on mineral areas.

Parts I and II have been revised considerably, and numerous references to recently published texts and articles on geology and prospecting have been added.

The aerial photographs are used with the permission of the Royal Canadian Air Force by whom they were taken.

J. S. RICHARDS,
Director of Mines.

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INTRODUCTION

This publication, "A Guide for Prospectors in Manitoba," is designed to set forth general information which will serve as a guide to the numerous metalliferous areas in the Province.

Particular attention is paid to the location and size of, and the means of access to, the different areas, and, in addition, brief summaries of features which are of interest to prospectors are added for each area.

Information is given regarding the staking and recording of mining claims. Together with this, some suggestions are made for the beginner as to necessary equipment and practice. Where it is desired to place emphasis on certain features in the text, italics or heavy type have been used.

The main purpose of the Guide is, however, to present the geological features of the mineral areas. As many of the geological terms of common use have a definite and restricted meaning, a glossary is included which will serve to simplify the reading and make the terms more readily understood.

The publication will serve also as a catalogue of geological reports dealing with Manitoba. A selected bibliography of reports on each area is added following the description of the area. To these reports the reader is referred for a more detailed study of the geology and other features. A complete bibliography of the geology of the Precambrian area of Manitoba has been published as Publication 51-1 and is available on request from the Manitoba Mines Branch.

More than three-fifths of Manitoba is underlain by rocks of Precambrian age. This large territory, more difficult to travel and less hospitable than the plains country to the south, was for many years regarded only as a fur country capable of supporting a comparatively small number of trappers and the scattered posts of the great fur-trading companies.

In the late seventies of the 19th century the Geological Survey of Canada commenced exploration of the western part of the Precambrian Shield, and during the next thirty years a few of its officers traversed a number of canoe routes and shorelines in Manitoba and noted the various rock formations encountered. Meanwhile, the Lake of the Woods mining boom in western Ontario caused the prospecting of some

small adjacent parts of Manitoba. The importance of the large Precambrian areas, however, was not recognized until the great discoveries at Cobalt and Porcupine, early in the present century, aroused keen interest in the possibilities of the entire North country.

In 1911 gold-bearing quartz veins were discovered at Rice Lake in the central Manitoba area northeast of Winnipeg. This attracted the attention of prospectors trained in the Ontario camps and the great wave of prospecting then sweeping northern Ontario reached out into Manitoba as far north as the line of the Hudson Bay railway where Tyrrell, Dowling, McInnes, and other officers of the Geological Survey of Canada, had reported favourable prospecting ground.

This movement of prospectors soon began to bear results, and gold was discovered at Herb Lake in 1914, and the Flin Flon and Mandy deposits on Flin Flon and Schist Lakes, respectively, were discovered in 1915.

The next event of importance was the first production of metals from Manitoba ore in 1917. In that year the Mandy mine contributed copper, gold, and silver from sulphide ore shipped to the smelter at Trail, B.C., and the Moosehorn claim at Herb Lake recorded the first production of gold from gold-quartz ore in a small shipment made to the same smelter. The Mandy ceased operations in 1920, and production for a number of years was confined to a small output of gold by different operators working intermittently. In 1943, Emergency Metals Limited, a subsidiary of Hudson Bay Mining and Smelting Co., Limited, resumed the production of Mandy ore on a 200-ton daily basis.

In 1924 and 1925 extensive development in the Central Manitoba, Herb Lake, and Flin Flon areas laid the foundation for the present production of metals, for at that time Central Manitoba Mines Limited, Hudson Bay Mining and Smelting Co., Limited, and San Antonio Gold Mines Limited were among the companies that commenced work.

The rising prices of the base metals coincided with this development, causing an increase of prospecting activity that culminated in the staking and recording of 10,853 mining claims in 1928. The collapse of metal prices early in 1929 brought this activity almost to a standstill, the low point being reached in 1930, but by 1931 interest in gold mining

was renewed. The search for gold continued to be the first interest of the prospector until recent years. Substantially higher base metal prices at present make this type of deposit more attractive.

In 1949 the Howe Sound Exploration Company, Ltd., commenced operations at their Nor-Acme Mine at Snow Lake at a rate of 2,000 tons a day.

In 1945, it became known that Sheritt Gordon Mines Limited had discovered nickel-bearing sulphides at Lynn Lake in northern Manitoba. This information immediately started a prospecting rush for nickel which, although it has abated, continues at present. In 1951 the decision was made to construct a railway from Sherridon to Lynn Lake, and present plans indicate production of nickel by 1953. This railway will make other northern areas accessible for prospecting.

To the end of 1930 the mineral industry was more or less in an experimental stage, and the total production of metals up to that time, from a number of properties working periodically, was only $4,161,393. Since 1930 the metallic production of the Province rose from $7,209,993 in 1931 to $15,353,047 in 1939, and to an all-time high ot $24,744,980 in 1950.

A close observation of prospecting in the Province over a number of years, and a review of the many excellent geological reports of the Geological Survey of Canada, together with those prepared for the province of Manitoba, *would indicate that apart from one or two localized areas, the greater part of the known mineral areas has been incompletely prospected, leaving large areas practically unexplored.*

The discoveries made in many of the older areas of the Precambrian in recent years *testify to the wisdom of careful and skilled work, and indicate that more detailed prospecting than has hitherto been done in these mineral areas is necessary.*

PART I

EQUIPMENT FOR PROSPECTORS

A few suggestions can be made to the man who is considering a prospecting trip and who has had little bush experience. If he plans to finance his own venture, and has not had much training, he would do well to secure a competent companion, or to enlist the services of another like himself and confine his activity to areas that are fairly well marked by trail.

Various arrangements may be made for financing a prospecting trip. Some men prefer to assume entire charge themselves. Others work on "grubstake," that is, all expenses are paid for them and they receive a substantial interest in any discovery they may make. Other prospectors, having considerable experience, are employed by some of the larger mining companies who are ever on the lookout for new properties.

The following list of necessary equipment, with the exception of personal equipment, should adequately outfit two men for much of a season, exclusive of staking charges on any discoveries made.

Prices of the major items are those in effect in October, 1950, as supplied by the Hudson's Bay Company, Winnipeg. In general these are minimum prices consistent with serviceability.

TRAVELLING EQUIPMENT

Canoe, 17-foot, prospector model, used $45.00; new	$145.00
Ambroid for patching (4 tubes)	1.50
One tent, 7 by 9 feet, with wall and floor (preferably silk, thereby saving weight), cotton duck, $27.50; silk	75.00
Three heavy woollen blankets or an eiderdown sleeping bag, $67.50	26.25
Two mosquito bars	7.00
Two packsacks	13.50
Two pack sheets with tump lines	12.95
Fly-oil ("6-12" or Di-methyl phthalate), 6—2 oz. bottles	3.00
Fly-Tox	1.00
Total	$285.20

Cooking Utensils

Two frying pans	$ 1.50
Nest of pails	4.00
Stirring spoon and fork	1.00
One butcher knife	1.50
Four tin plates	1.30

At the Portage—A pause in the life of the prospector.
On the Echimamish River.

Cooking Utensils—*Continued*

Four pannikins (tin cups without handles)	$ 1.80
Three each of knives, forks, teaspoons, and tablespoons	1.00
Dish towels, 2 yards	1.00
Fishing line, trolls, etc.	2.00
Flashlight, extra cells and bulbs	2.00
First aid kit, Auto type	3.00
Total	$ 20.10

Tools

Two light camp axes, 2½ lbs.	$ 7.50
One bricklayer's hammer or prospector's pick	2.50
One long handled grub-hoe and hammer	2.50
Mortar and pestle and sieve	4.00
Gold pan	4.00
Small moil	.50
Geological maps, "mounted," notebook and pencils	.50
Prospector's handbook and box of mineral samples	
Total	$ 21.50

Provisions for Two Men for One Month

50 pounds flour
40 pounds bacon and pork (long clear)
6 pounds butter
6 pounds beans
4 pounds rice
2 pounds raisins
3 pounds cornmeal
6 pounds rolled oats
3½-pound bag of salt
1 can pepper
2 dozen candles (short)
½ gallon, or 10-pound tin corn syrup
2 pounds tea
2 pounds coffee or cocoa
1 pound baking powder
3 pounds dried apples
3 pounds dried peaches
3 pounds dried prunes
3 pounds dried apricots
30 pounds sugar
1 dozen soup tablets
1 dozen oxo cubes
1 pound pot barley
1 pound split peas
2 tins dehydrated potatoes
30 small cans evaporated milk or equivalent of powdered milk.
Abundant supply of matches

The weight of the above should be approximately 200 pounds and the cost, depending on locality, from $70.00 to $75.00. Outfitters in the north will put these supplies in cotton bags of various sizes with tie strings attached—a necessary convenience for packing. *Paper bags are useless.*

Personal Equipment

Each man should carry his own watch, *waterproof* match box, compass ($10.00), magnifying glass ($10.00), and hunting knife ($3.00)	$ 23.00

Clothing should be cut to the minimum in order to save space and weight. The following, per man, should be ample for the summer's work:

Heavy khaki shirt and pants	7.00
Extra shirt	3.25
One light sweater coat, woollen	5.00
3 pairs woollen socks	3.00
2 suits woollen underwear	9.00
Rubber-bottom swamp boots (leather tops)	10.00
Light canvas shoes for camp	2.50
Towel and soap, razor, *metal* mirror	3.00
Total	$ 65.75

The total cost of the above items is $463. The sum of $600, apart from rail or motoring costs would, therefore, see two men completely outfitted and on the trail, bound for some likely prospecting ground. In the event of staking a group of claims, however, there will be the added expenses of railway transportation, recording fees, and incidental living expenses. Two men planning to spend a season at prospecting, say from May 15 to October 1, should have available at least $1,000. Wages are not included.

Axes and Prospecting Picks—These are important; the axe and matches, in the last analysis, are the two most important articles the prospector carries, and they have meant life to many a man in the bush. The axe should weigh around 2½ pounds, have a 27-inch hickory handle, and be hung at such an angle that it cuts on the stroke. There are two kinds of picks: the short-handled geologist's pick, and the long-handled instrument with pick end to remove moss and a hammer to break off samples. Prospectors in Manitoba favour the long-handled pick and also often carry a small belt axe for blazing trees, etc. Some prefer a bricklayer's hammer to the small prospecting pick. A *watertight* match-holder is necessary.

The Compass—In the field the prospector should learn to rely upon his compass and from time to time to check his readings on the sun, particularly if he happens to be in an area in which he suspects "local attraction." Mineral zones sometimes cause marked deflections in the direction of the compass needle. If a watch showing correct local time is carried, a ready check on the compass is available. Hold the watch horizontally. Then turn it till the shadow of a twig or blade of grass, held vertically beside it, falls along the *hour* hand. Due south will then lie *halfway* between the hour hand and the 12 o'clock position. This gives true (not magnetic) directions. A simple calculation, on the same basis gives the true bearing to the sun at any time, if one remembers that each minute division on the watch covers six degrees.

The prospector should learn to travel as far as possible from established water courses, at the same time keeping a close check on his position. This is important not only for

safety's sake but, should a discovery be made, the exact location is desirable for the preparation of his claim sketches.

Sampling—If he is fortunate enough to make a discovery of a quartz vein bearing valuable minerals, the prospector should be extremely diligent in sampling the occurrence. The immediate purpose of the sampling is to find the value of the rock across a "minimum stoping width," usually taken to be about three feet. This is the smallest space in which a miner can be expected to work. As this much rock, at least, must be broken to allow the miner to enter, it should contain value enough to pay for the cost of his work. This obviously requires that the whole of this width should be sampled, as a single piece of the best looking material gives no indication of the value of the remainder.

The process is known as "channel sampling." The samples should be cut across the vein at short intervals, say every 20 feet. Each sample should be cut at right angles to the vein wall, and should be at least 2 inches wide and 1 inch deep. Normally the length of individual samples should not exceed 5 feet; if the vein is wider than 5 feet take two or more samples. It is usually advisable to take a few inches of the wall-rock also as a separate sample, for it, too, may contain valuable minerals.

The sample is "cut" by chipping the vein material onto a canvas sheet by means of a moil and hammer. Care should be taken to get *only* the material from the channel, but to get *all* of it, including the "fines."

Carefully cut samples are worth the trouble spent on them. It is much easier to arouse interest in a property that has a few good channel samples than in one from which only grab samples have been taken. In the final analysis, grab samples show only that mineralization is present, without telling anything about the grade of the ore when mined.

Further exploratory work on a mineral occurrence should be done under the direction of someone thoroughly experienced in that type of work. Misdirected work of this type is very expensive, and it is of the utmost importance to have the property well prepared for examination by mining scouts, geologists, or engineers.

FOREST FIRE PROTECTION

Every precaution should be taken while travelling in the northern woods, especially during the hot summer months, to protect the forests from fire. Remember, your own life and the life and livelihood of others may depend on the care you exercise in this respect.

The forests of Manitoba belong to the people of Manitoba; protect them for your own use and the use and enjoyment of others. Remember, timber will be necessary in mining operations.

Do not build your camp fire in a dry, mossy place or against dry stumps or logs. Select a spot on which there is the smallest quantity of combustible material and from which there is the least likelihood of the fire spreading. Remove all dead trees, branches, or vegetable matter within a radius of 10 feet of the fire, and use all reasonable precautions to prevent such fire spreading. Scrupulous care with fire is a mark of a good woodsman.

Do not forget to see that your fire is absolutely out before leaving camp. Use lots of water or cover it with sand or clay. Anyone leaving a camp fire burning is liable to a maximum fine of one hundred dollars or six months' imprisonment.

Any Forest Ranger or Fire Ranger may call out any male citizen to assist in fighting forest fires. Fire signs or Forest Service property must not be interfered with. Persons while travelling through the woods when requested to do so by a forest officer, must give information as to their name, address, movements, etc.

The Manitoba Forest Service will assist you in every way possible with information that may help you in your work, and they ask for your co-operation in preventing the destruction of the forests.

PREVENT FOREST FIRES—IT PAYS

STAKING AND RECORDING OF MINING CLAIMS

With the transfer of the natural resources to the Province of Manitoba, a Mines Act was passed by the Legislature in 1930 and regulations for the disposal of mining claims were adopted under the provisions of this Act. Generally speaking, the regulations follow in principle the Quartz Mining Regulations as in force at April 1, 1929, under the Mineral Lands Administration, Department of the Interior.

For full information regarding the manner in which mining claims may be taken up and held, reference must be made to the Regulations under "The Mines Act" for the disposal of mining claims. These regulations have been revised to April, 1950.

For the convenience of those interested, a brief summary of the regulations is given. The section numbers in the following paragraphs refer to these regulations.

Who May Prospect

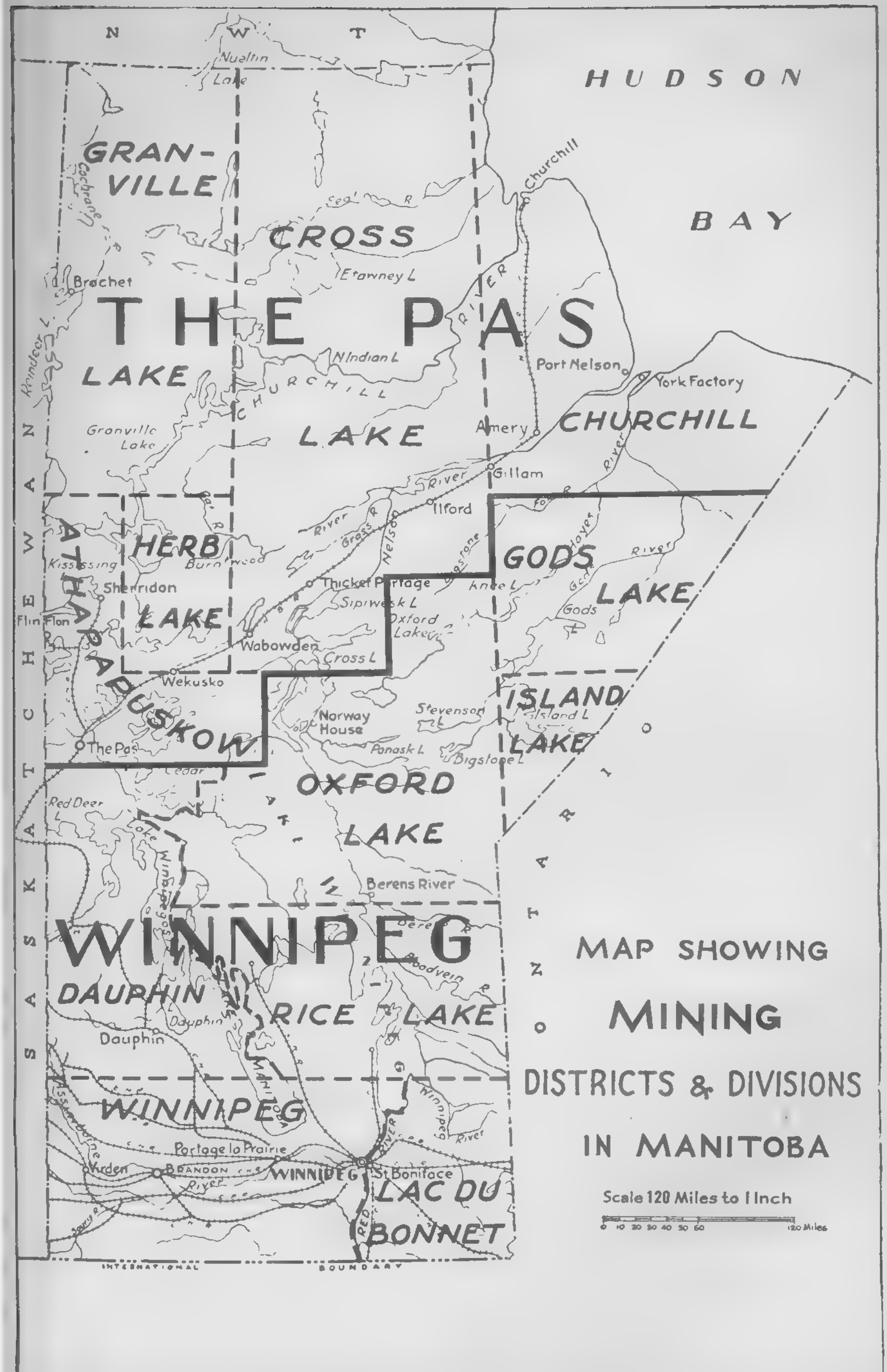
Every person of the age of eighteen years or over who has obtained a miner's license is entitled to prospect for minerals on vacant Crown Lands of Manitoba. Miner's licenses are obtainable at the Mining Recorders' offices, Winnipeg or The Pas, Manitoba. The fee for a license is $5.00. A license expires at midnight on the thirty-first day of March. Licenses are not transferable, but are renewable.

Mining Districts and Divisions

The Province is divided into two mining districts:

(1) *The Winnipeg mining district* includes southern Manitoba and all the country east of, and tributary to, Lake Winnipeg. The farthest north prospecting areas in this district are Knee, Oxford, Gods and Island Lakes. Claims staked in the district must be recorded at the Mining Recorder's office, Winnipeg.

(2) *The Pas mining district* comprises all northern Manitoba north of the Hudson Bay railway, and a fringe south of the railway and tributary to it, such as Cross Lake, the Fox River, and the lower Nelson River areas. Claims staked in



MAP SHOWING MINING DISTRICTS & DIVISIONS IN MANITOBA

the district must be recorded at the Mining Recorder's office, The Pas.

Number of Claims That May Be Staked

Each mining district is divided into a number of divisions and a licensee may, in any one license year, in any one mining division, stake out and apply for *eighteen mining claims*.

For particulars as to lands not open for staking, such as Indian Reserves, Dominion Parks, townsites, etc., see sections 11 and 12. For application of the Forest Act to mining claims see sections 14 and 15.

Staking of Claims

A mining claim in unorganized territory is 1,500 feet square with boundary lines running as nearly as possible north and south and east and west astronomically; see sections 19 and 20. In staking, a post is placed at each corner of the claim and the boundary lines are brushed out. Trees on the lines are blazed on two sides only.

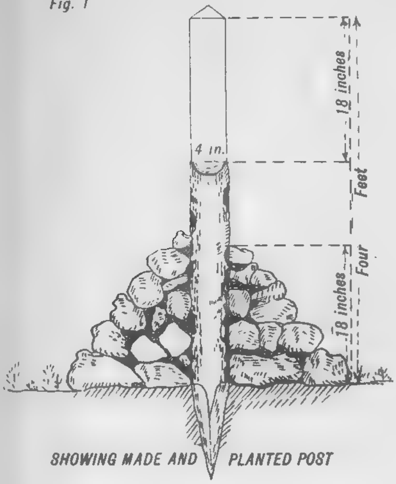
The diagrams shown in figures 1-8 and the sketch plans are intended to illustrate sections 22-26 and 31 of the Regulations. They give in detail the information required on each of the posts, as well as showing how the post is made, planted, and mounded. The sketch plans show how a claim is staked on the shore of a body of water and its relation to other claims staked on land adjoining.

Prospector's Reservations

In certain parts of the Province a prospector may stake out a "prospector's reservation," four square miles in area, surrounding a claim on which he has made a discovery of mineral. The reservation is in the form of a square with sides two miles long, lying N-S and E-W, and each one mile distant from the No. 1 post of the discovery claim. The boundary lines are posted and blazed, much as for claim lines.

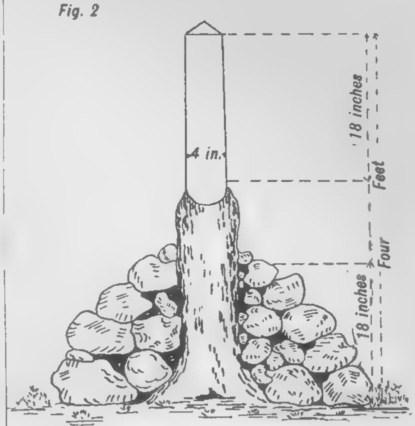
The reservation gives the prospector sole staking rights within that area for a period of six months, but will not be granted within a radius of fifteen miles of any previously recorded claim or prospector's reservation in good standing. See section 77.

Fig. 1



SHOWING MADE AND PLANTED POST

Fig. 2

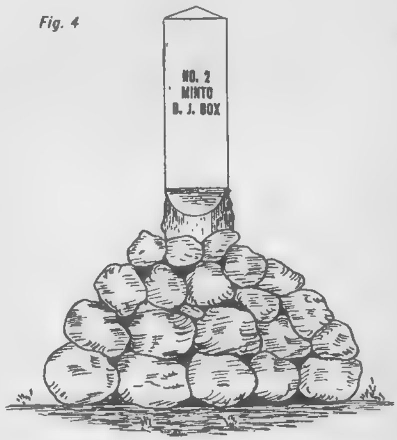


SHOWING STUMP OF TREE MADE INTO POST

Fig. 3

SKETCH OF POST AND MOUND SHOWING MARKING ON LOCATION POST No. 1 OF MINTO CLAIM STAKED BY B. J. BOX, OWNER OF LICENSE No 23, AT 3.15 P.M., AUG. 10, 1929.

Fig. 4



SKETCH OF POST AND MOUND SHOWING MARKING ON LOCATION POST No. 2 OF MINTO CLAIM-STAKED BY B. J. BOX,

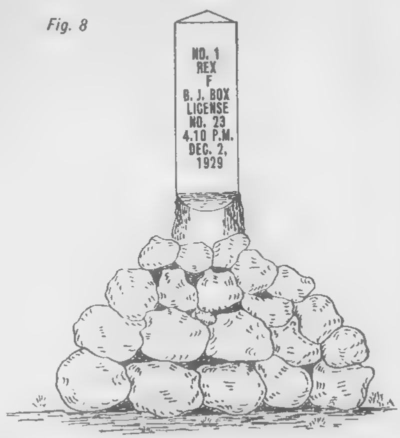
Fig. 5

SKETCH OF POST AND MOUND SHOWING MARKING ON WITNESS POST No. 3 OF MINTO CLAIM STAKED BY B. J. BOX.

Fig. 7

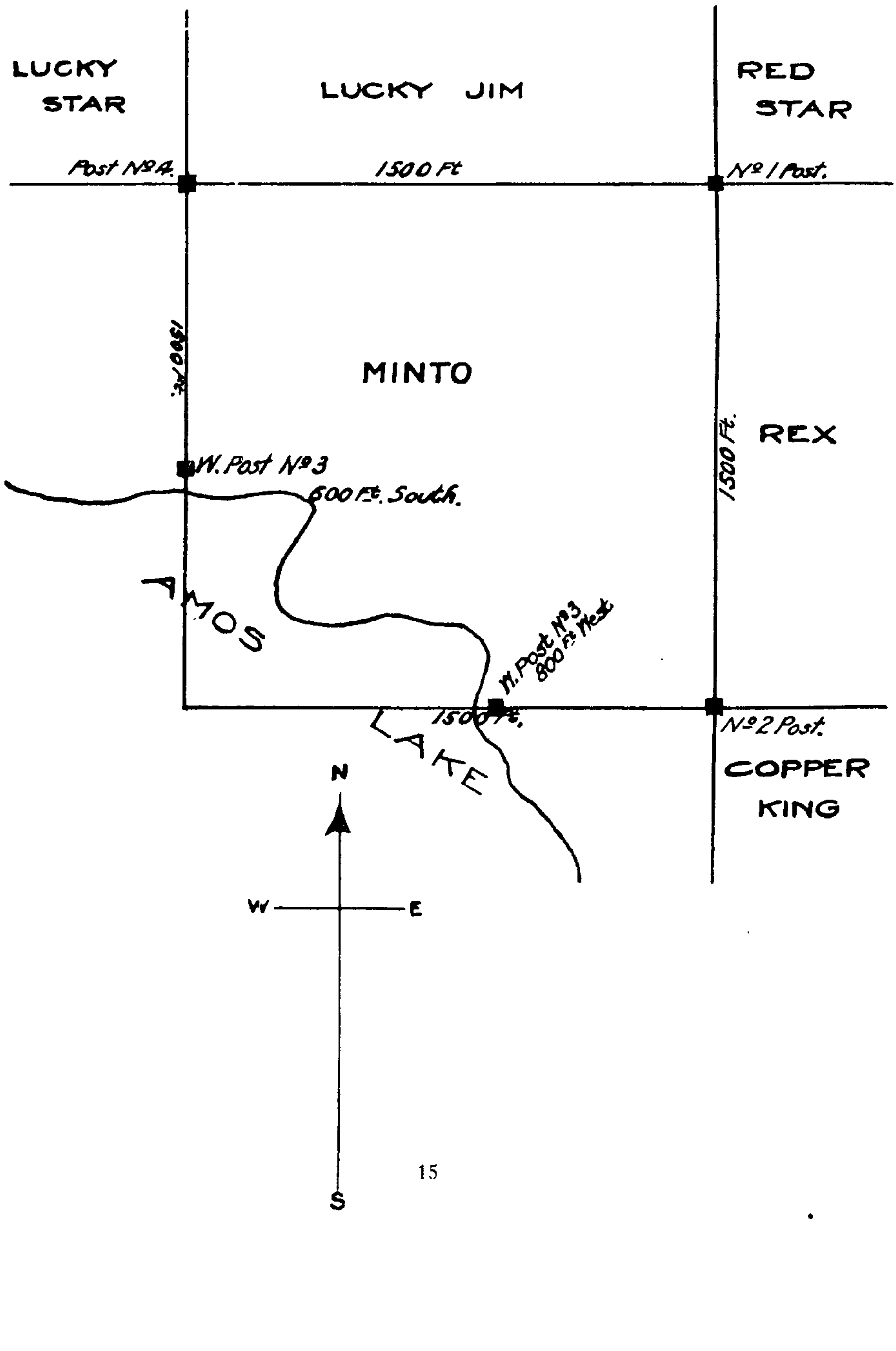
SKETCH OF POST AND MOUND SHOWING MARKING ON LOCATION POST No. 2 OF STAR CLAIM STAKED BY B. J. BOX, ON BEHALF OF W. BROWN

Fig. 8

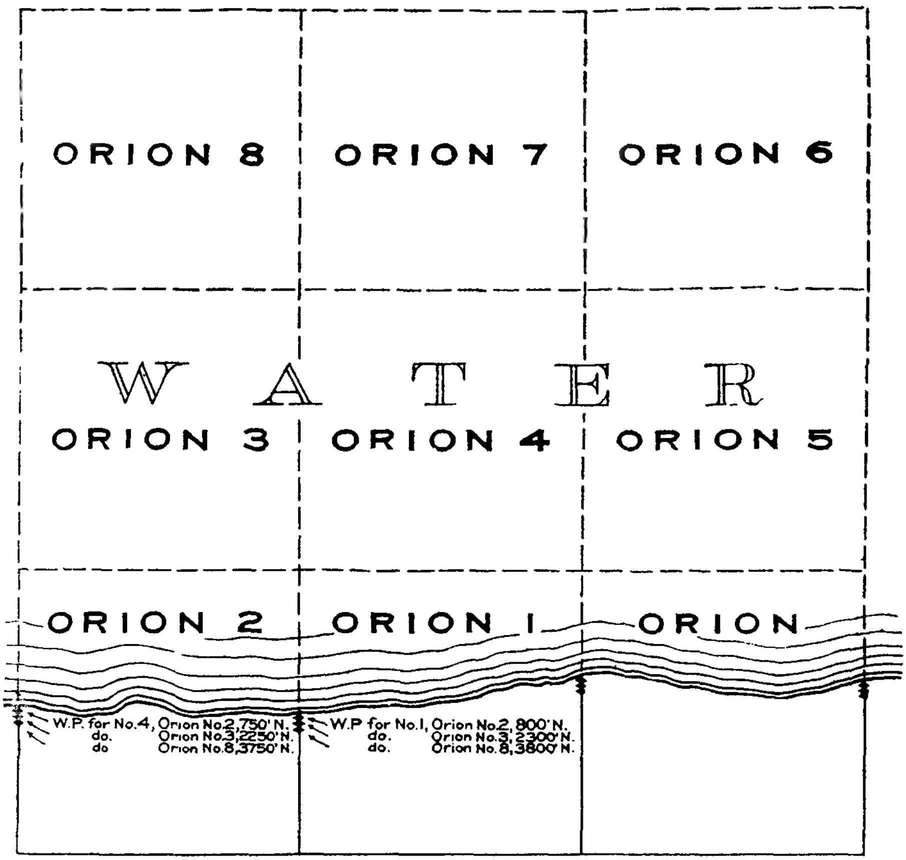


SKETCH OF POST AND MOUND SHOWING MARKING ON LOCATION POST No. 1 OF REX FRACTION STAKED BY B. J. BOX, OWNER OF LICENSE No. 23, AT 4.10 p.m., DEC. 2. 1929.

SKETCH PLAN OF MINTO CLAIM



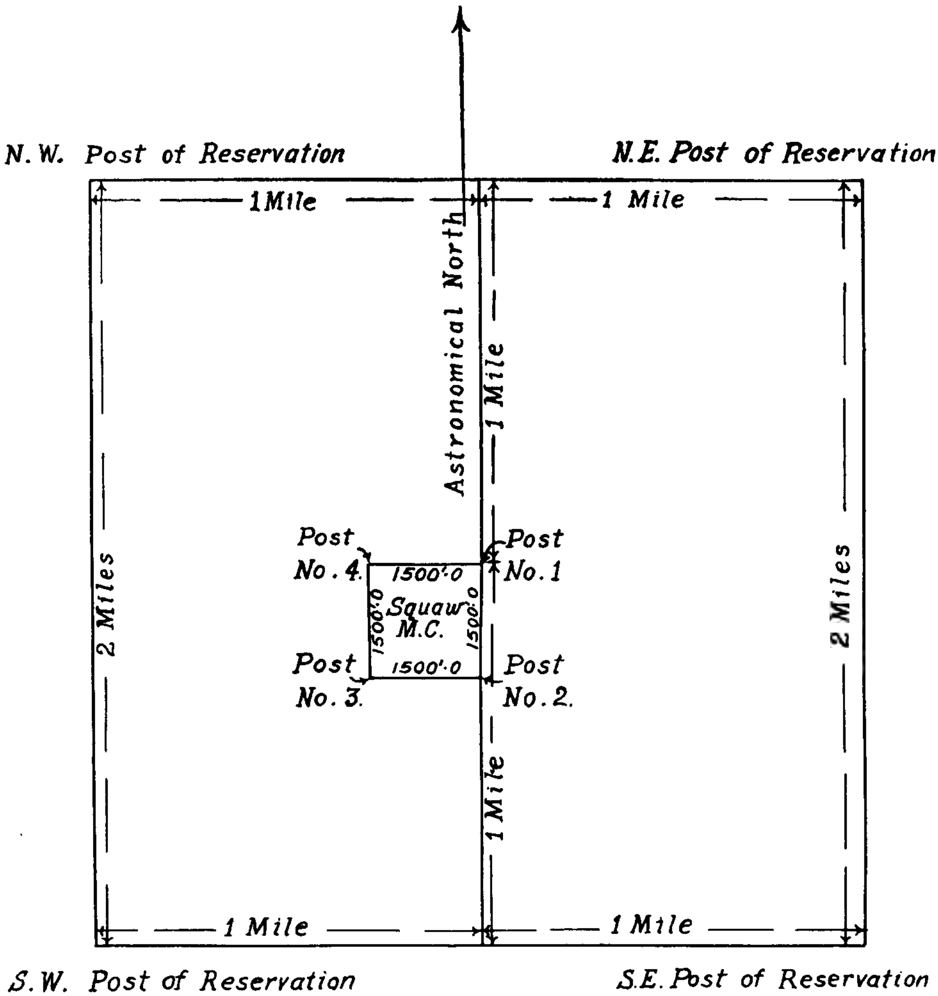
METHOD OF STAKING WATER CLAIMS



Note: Northerly Posts only are necessary for claims staked northerly as shown
When staking claims southerly Posts 2 and 3 will be witnessed.
When staking claims easterly Posts 1 and 2 will be witnessed.
When staking claims westerly Posts 3 and 4 will be witnessed.

Recording of Staking

If a claim is staked within ten miles of the office of the Mining Recorder of a district, an application to record the claim must be made at that office within fifteen days. For every additional ten miles' distance in direct route, one additional day is allowed for filing application to record. See section 36.



Showing method of staking a prospector's reservation.

Metal tags obtained from the Mining Recorder, showing the recorded number of the claim, are required to be affixed to all of the corner posts after recording. See section 41.

Fees for recording mining claims are $5.00 per claim.

Assessment (Representation) Work

Claims are held from year to year by the performance of assessment work. For this purpose the following are accepted, for each full claim, each year:

(a) Removal of 144 cubic feet of solid rock by trenching, shaft sinking, or test-pitting; or,

(b) Removal of 288 cubic feet of overburden by stripping, shaft sinking, or test-pitting; or,

(c) 35 feet of diamond-drilling, regardless of size of drill or core; or,

(d) Claim survey by a Manitoba land surveyor; or,

(e) Geological survey of the claim by a qualified geologist; or,

(f) Geophysical survey by a qualified operator.

These are subject to certain qualifying regulations. See section 52.

However, if the area of a claim, staked as a fractional claim, is less than twenty-five acres, the work required to be done each year in mining operations is one-half that required under the regulations in respect of a full claim. See section 53. An affidavit containing a detailed statement of the work performed must be furnished to the Mining Recorder for the district in which the claim is situated, within one month after the expiry of the year in which the work must be performed; otherwise the claim lapses and the ground is open for re-location under the regulations. See sections 54 and 55.

Claims up to thirty-six in number may be grouped so that the annual work for the group may be performed on any one or more of the claims. See section 51.

Purpose of Regulations

It is intended as far as possible, to protect the honest prospector who complies substantially with the requirements of the regulations from being defeated of any just claim by

technicality, but a prospector should always endeavour, if he desires to avoid trouble and possibility of loss, to follow the regulations as carefully and as accurately as possible.

As it has been the intention to limit this guide to prospecting, such questions as the obtaining of a lease to a mining claim, surface rights compensation, transfer of a mining claim, etc., have been omitted from these notes.

Regulations governing these items in detail, maps, blank forms, and other general information can be obtained from the Chief Mining Recorder, Mines Branch, Department of Mines and Natural Resources, Winnipeg, or Mining Recorder, The Pas, Manitoba.

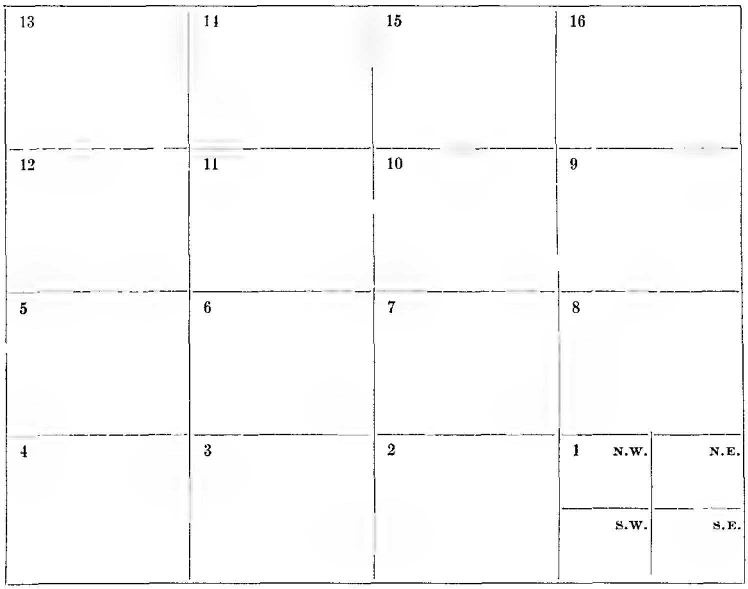
MAPS FOR PROSPECTORS

The Surveys Branch of the Department of Mines and Natural Resources, Winnipeg, prepares blue prints of mining claim locations in Manitoba for the use of prospectors. These blue prints are kept up-to-date and assist the prospector in locating ground open for staking and also serve as a guide to his operations in the field. In their preparation a direct relationship is maintained to the National Topographic series of maps compiled by the Topographical Survey of Canada from aerial photographs. These are frequently referred to as "aerial" or "topographic" maps.

The following is a description of the method used in outlining the limits of one of the topographic maps. If the prospector understands the manner in which the boundaries of this map are determined and the relationship between the "claim" map and the "topographic" map he will be able at any time to write in a request to the Mining Recorder's office, either at Winnipeg or The Pas, for a mining claim map by its correct designation.

Maps of the National Topographic series are compiled mostly from aerial photographs and are on a scale of 4 miles to 1 inch. Each map embraces the area contained between consecutive latitude circles one degree apart (north and south) and between meridians of longitude of even number i.e., two degrees apart (east and west). Each map covers an area approximately 80 miles east and west by 68 miles north and south.

In the compilation of the blue prints of mining claims, the area shown is one sixty-fourth of that embraced by a topographic map, and the subdivision of the topographic map is made as follows: each map of the National Topographic series is divided into sixteen rectangles (see sketch on following page) numbered in the southern row from right to left, from 1 to 4; in the second row, from left to right, from 5 to 8; and so forth up to sixteen. Each of these rectangles is in turn subdivided into quarters, designated S.E., S.W., N.W., N.E. The mining claim map that is numbered S.W. 4-52-M thus indicates the southwest quarter of rectangle 4 of the National Topographic map No. 52-M.



From the above sketch it may be seen that the area of the claim map showing the mining claims in the southeast quarter of rectangle 1 is one sixty-fourth of the area of the topographic map whose size is represented by the sum of all the rectangles. It will be seen that the scale of the mining claim blue prints is 8 times that employed on the National Topographic series of maps.

AERIAL PHOTOGRAPHS

Large areas of the Province have now been photographed from the air, and copies of the photographs are available. These photographs are of considerable assistance to the prospector. They are not only extremely detailed maps but also, frequently, indicate the structure and the type of rock present. Such features as major faults, contacts, folds, and variations in lithology may show clearly. The differences which show are, actually, differences in elevation and vegetation which result from the rock changes beneath.

Detailed interpretation of aerial photographs requires a high degree of skill, but many of the broader features are recognizable without much trouble. Included as pages 23

and 24 are two vertical photographs of Manitoba areas which have been mapped geologically by the Mines Branch. A comparison between the photograph and the geological map printed on the transparent overlay will serve to indicate the manner in which some of these features appear on the photograph.

Aerial photographs are of two types—vertical and oblique, The "vertical" is taken by a camera pointing straight down from the aircraft, and is much the more useful type; the "obliques" require elaborate corrections to remove distortion to the shape and size of the objects shown. By using two adjacent vertical photographs and a pocket stereoscope the hills and valleys are also visible; in fact, these appear more clearly than they are actually seen by an observer flying over the land.

Vertical photographs are available on various scales from:

> National Air Photo Library,
> Department of Mines and Technical Surveys,
> No. 8 Building, Ottawa, Ontario.

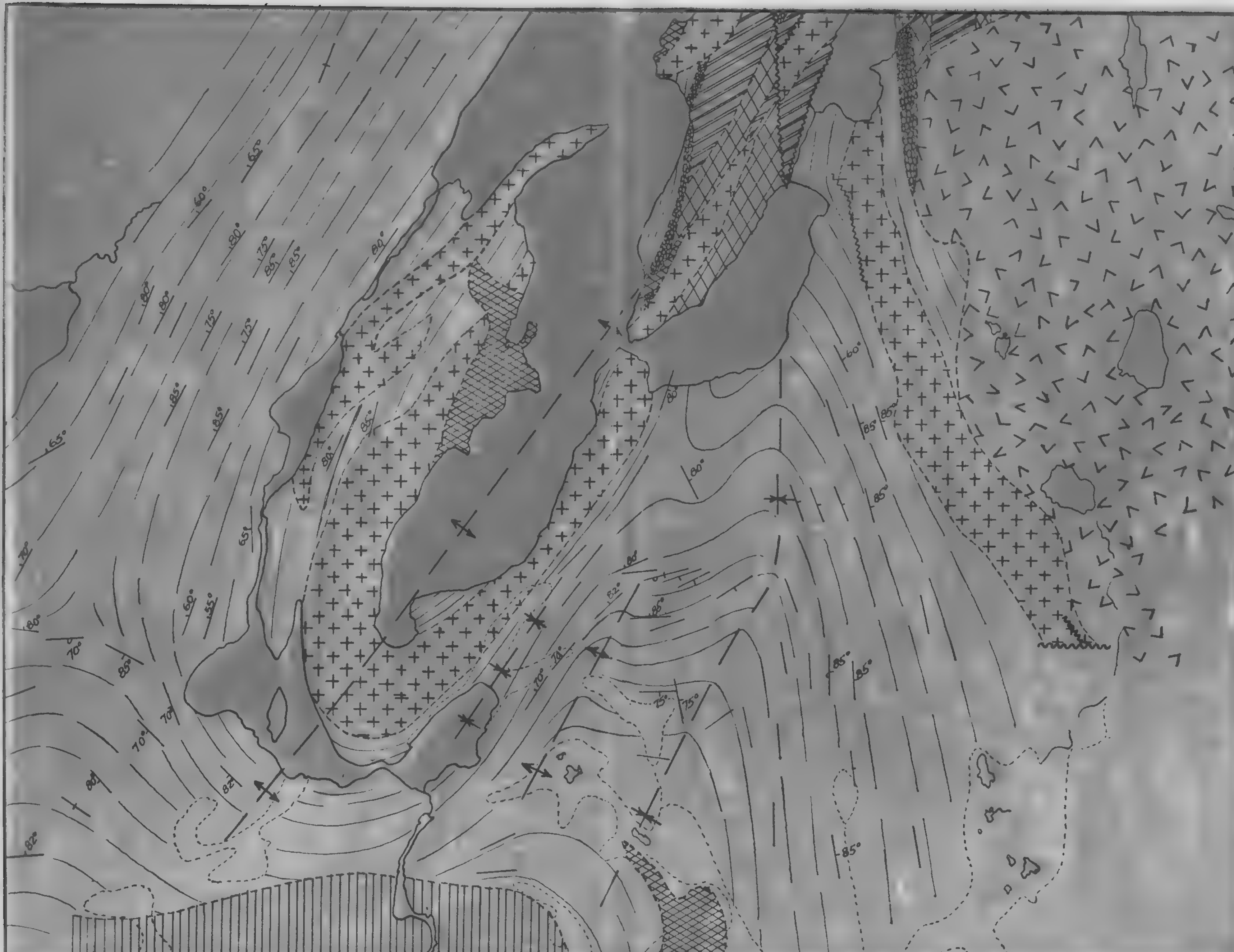
When ordering photographs the prospector should give the following information:

(*a*) The boundaries of the area for which he wishes photographs. This may be given as latitude and longitude, which can be read off the ordinary topographic map.

(*b*) The scale he wishes. Certain areas are available on scales of 1,320 and 2,460 feet to 1 inch. In other areas one or the other scale is available, but not both.

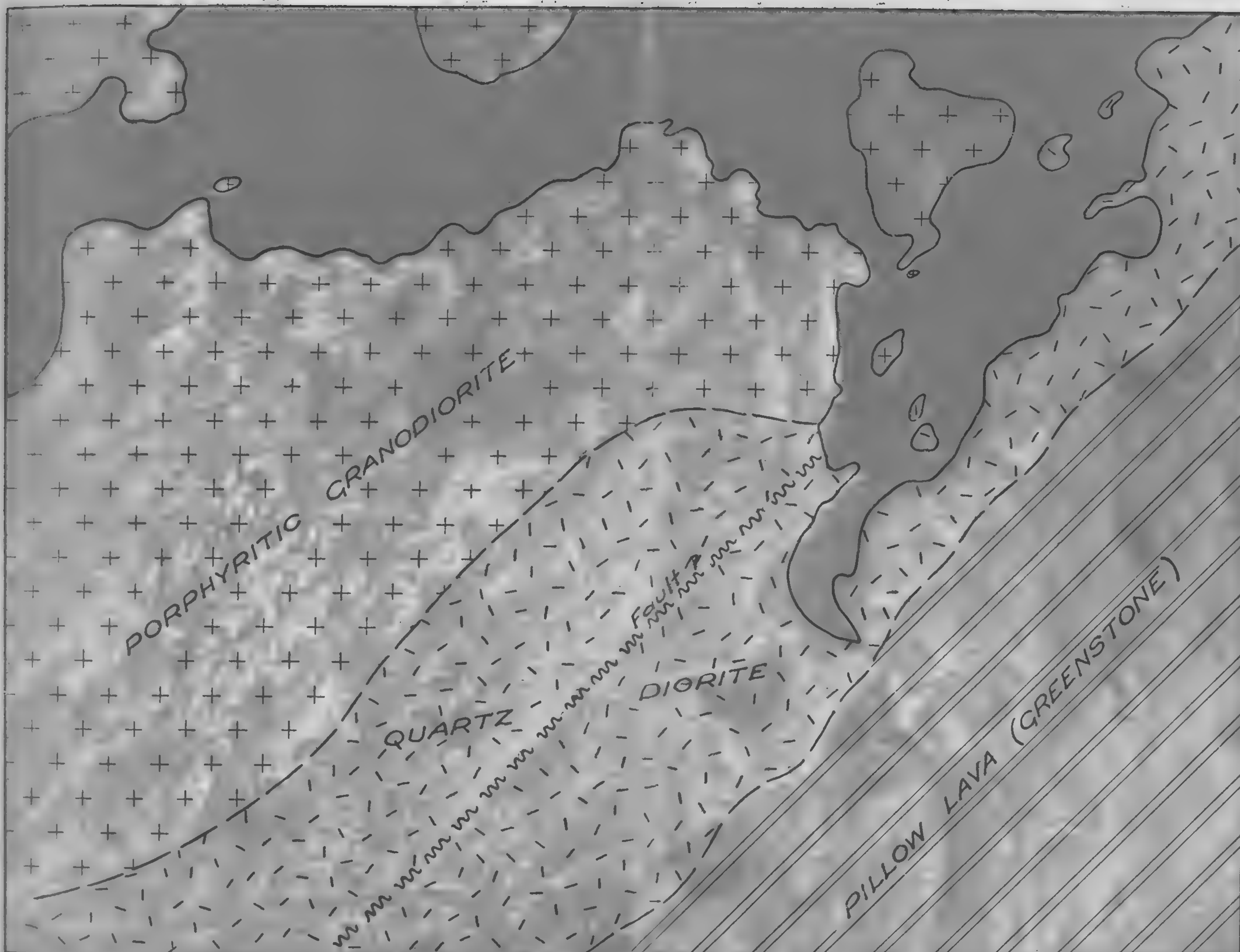
(*c*) Whether he desires dull or glossy prints. Dull finish is recommended because notes can then be made directly on the photograph. The cost is the same.

(*d*) Whether or not stereoscopic pairs are required. For use with a stereoscope a considerable overlap of adjacent photos is necessary; unless the prospector has a stereoscope the overlap is not essential. Since the prints are quite expensive, a considerable saving can be made by using only every second photo along each flight line.



The topographic expression of structure and changes in rock type is frequently visible on aerial photographs.
(A portion of Beau-Cache Lake Area, Manitoba Mines Branch Map 50-8) *Royal Canadian Air Force Photograph*

Royal Canadian Air Force Photograph



Faulting and change of rock type as shown on an aerial photograph.

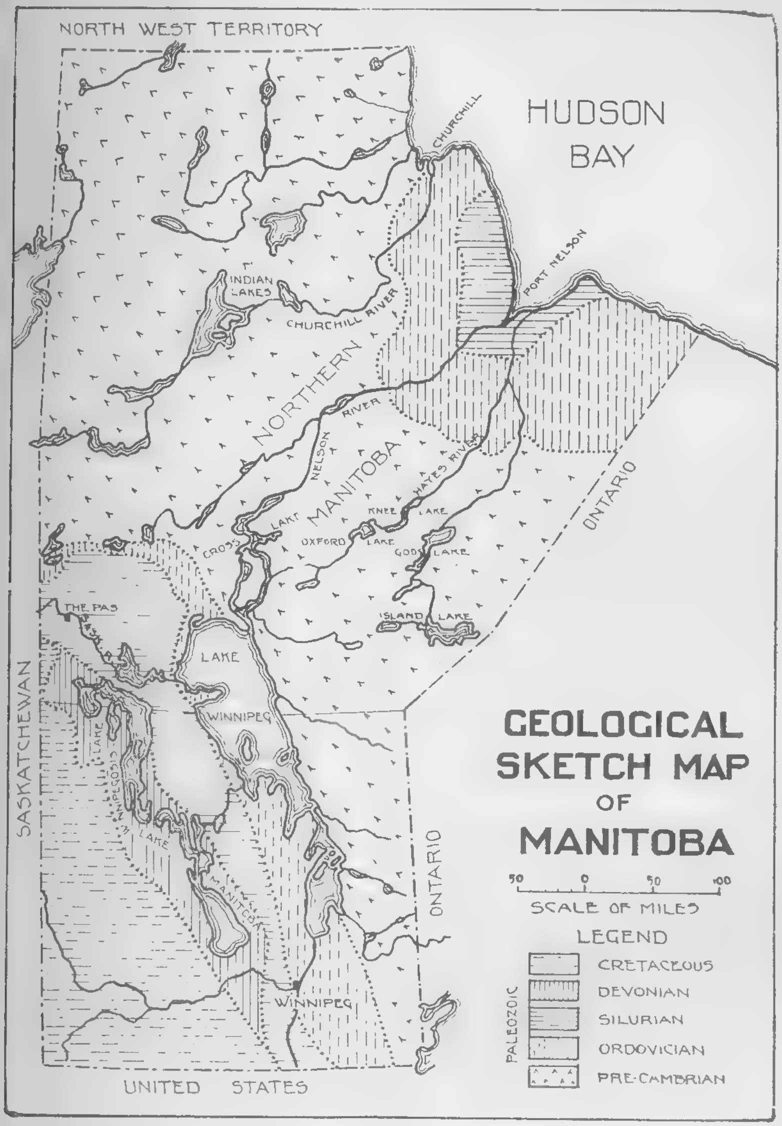
[illegible]al Canadian [illegible] F[illegible] [illegible]hotograph

Royal Canadian Air Force Photograph

PART II

GEOLOGY OF MANITOBA

The area of the province of Manitoba is 251,832 square miles. In this vast expanse of territory considerable differences in the nature and topography of the land surface occur. The south and southwestern parts are physiographically the



eastern extension of the Great Plains region, characterized by deep soil cover and much open prairie and agricultural land.

To the east, northeast and north the so-called Plains country merges imperceptibly, rarely abruptly, into what is known variously as the Laurentian Plateau, the Precambrian Shield, or the Canadian Shield, part of a vast region which surrounds Hudson Bay and differs from the plains to the west in showing a generally rougher surface, numerous glaciated outcrops of ancient rocks, and innumerable depressions occupied by lakes and muskegs.

Another area, the Hudson Bay slope, for a considerable distance inland from the coast, extending along the lower reaches of Churchill and Nelson Rivers, is underlain by flat-lying Palaeozoic rocks, is mostly drift-covered and presents a topographic form different from that of the Precambrian Shield which surrounds it.

This guide deals entirely with Precambrian formations which cover over three-fifths of the Province and are the great hunting ground of the prospector for metallic minerals. The pages immediately following are intended as a guide to the interpretation of geological reports on the Precambrian.

PETROLOGY

The various types of rock encountered in the Precambrian are broadly classified as: (1) *Sediments*, rocks formed by the consolidation of particles transported to the site of deposition by wind or water; (2) *Igneous* rocks, originally emplaced while molten; (3) *Metamorphic* rocks, formed by changing the form (*metamorphism*) of either of the other two.

The *sediments* are subdivided according to the size of the grains of which they are composed:

(*a*) *Conglomerate*, composed of boulders and pebbles held together by a finer grained matrix.

(*b*) *Sandstones*, originally composed of grains of sand, now cemented together.

(*c*) *Shales*, formed from the consolidation of fine-grained muds.

As usually seen in the Precambrian areas, the sandstones are in the form of quartzites (composed almost entirely of quartz) or arkoses (quartz and feldspar); the original sand grains may or may not be recognizable. The shales have usually altered to slate or to schist.

The *igneous* rocks are subdivided according to the conditions under which they are believed to have solidified:

(*a*) *Intrusives* (plutonics), which invaded the country rock while molten and solidified under a thick cover of the country rock. The blanket of overlying rocks caused slow cooling, and as there was time sufficient for the component crystals to grow to large size, the rocks are typically coarse grained and massive. Granites, diorites, and gabbros are examples of intrusive rocks.

(*b*) *Volcanics* (lavas), which flowed out onto the surface of the earth through volcanic vents and froze on the surface or under water. The rapid cooling typically results in a very fine-grained rock or glass, but, most volcanic rocks in the Precambrian Shield have been recrystallized and have a coarser grain than originally. Dacites, andesites, and basalts (greenstones) are examples of volcanic rocks and are, respectively, the volcanic equivalents of granites, diorites, and gabbros mentioned above.

(*c*) *Dykes*, which were introduced as thin tabular masses into the cold country rock. They cooled at rates intermediate between the intrusives and the volcanics and are commonly fine grained. Diabase is an example of a dyke rock.

In most geological reports igneous rocks are given names which tell whether or not they are intrusives, extrusives, or dykes, and at the same time tell their chemical composition; factors which may be important in localizing ore bodies within them. The chemical composition is usually revealed by the minerals present in the rocks, e.g. quartz, feldspars, and ferromagnesian minerals (such as hornblende or biotite) in a granite. Numerous elaborate classifications of igneous rocks have been evolved, but the following simple one is adequate for the present purposes:

	Free Quartz Present		Little or No Free Quartz				Olivene present No quartz			
	More orthoclase than plagioclase feldspar	More plagioclase than orthoclase feldspar	More orthoclase than plagioclase feldspar	More plagio-clase than orthoclase feldspar	Little or no orthoclase. Plagioclase high in anorthite	No feldspars	Plagioclase high in anorthite	No feldspar	Nepheline	Leucite
Plutonic (Intrusive)	Granite	Granodiorite	Syenite	Diorite (Hornblende is the common ferromagnesian mineral)	Gabbro	Perknite (Pyroxenes, Amphiboles, Oxides, Sulphides)	Olivene Gabbro	Peridotite (Dunite, if pure Olivene)	Nepheline Syenite	Leucite Syenite
Dyke	A P L I T E S						Lamprophyres		Aplite, Porphyry, Tinguaite	Leucite Trap
	P O R P H Y R I E S						Olivene diabase			
	Felsite	L A M P R O P H Y R E S								
					Diabase					
Volcanic (Extrusive)	Rhyolite or Obsidian	Dacite	Trachyte	Andesite	Basalt		Olivene basalt	Olivene basalt	Phonolite	Leucite basalt

(After G. W. Tyrrell: "The Principles of Petrology, 4th Ed. 1937, p. 108)

As an example, a rock described as a diorite, would be a dark intrusive rock composed mainly of plagioclase feldspar and dark minerals such as hornblende, but it would contain little or no free quartz. In the same way, a medium- to coarse-grained intrusive rock containing abundant orthoclase and quartz as well as plagioclase, but small amounts of biotite (or hornblende) would be called a biotite (or hornblende) granite.

The *metamorphic* rocks, through derivation from both sediments and igneous rocks, as well as other metamorphics, have the widest range in composition and characteristic minerals. As usually encountered they are in the form of *schists* or *gneisses*. The schists are composed of platy minerals, such as the micas, arranged parallel to one another. This gives a very marked platy *cleavage* to the resulting rock and a tendency to break readily into thin slabs. Such schists are commonly found in shear zones and strongly folded areas. They are usually described by listing the characteristic minerals present, as in "garnet schists," "staurolite schists," etc. They may be derived from a large variety of original rock types. The gneisses are characterized by a parallel banding, or *foliation*, of different minerals. Usually these bands are alternating dark and light and up to about ½ inch thick; they are composed of such minerals as quartz and feldspar in the lighter bands and biotite, hornblende, and other minerals in the dark bands. Garnets and other metamorphic minerals are common and characteristic in both the gneisses and schists.

Strictly speaking, quartzites and greywacke are both metamorphic rocks, as is marble, but these are usually considered under the heading of sediments. Greywacke is a term which is used with different meaning by different writers, and in different areas. It usually means a sandstone, or its metamorphosed equivalent, derived from the disintegration of a basic igneous rock. Consequently, it has a higher proportion of dark minerals than the usual quartzite.

Some geologists also believe that many granitic rocks are formed by the metamorphism of sediments, through a process called *granitization*. This is thought to involve the addition of material to the sediment, and its recrystallization, to produce a rock which, for all intents and purposes, is a granite.

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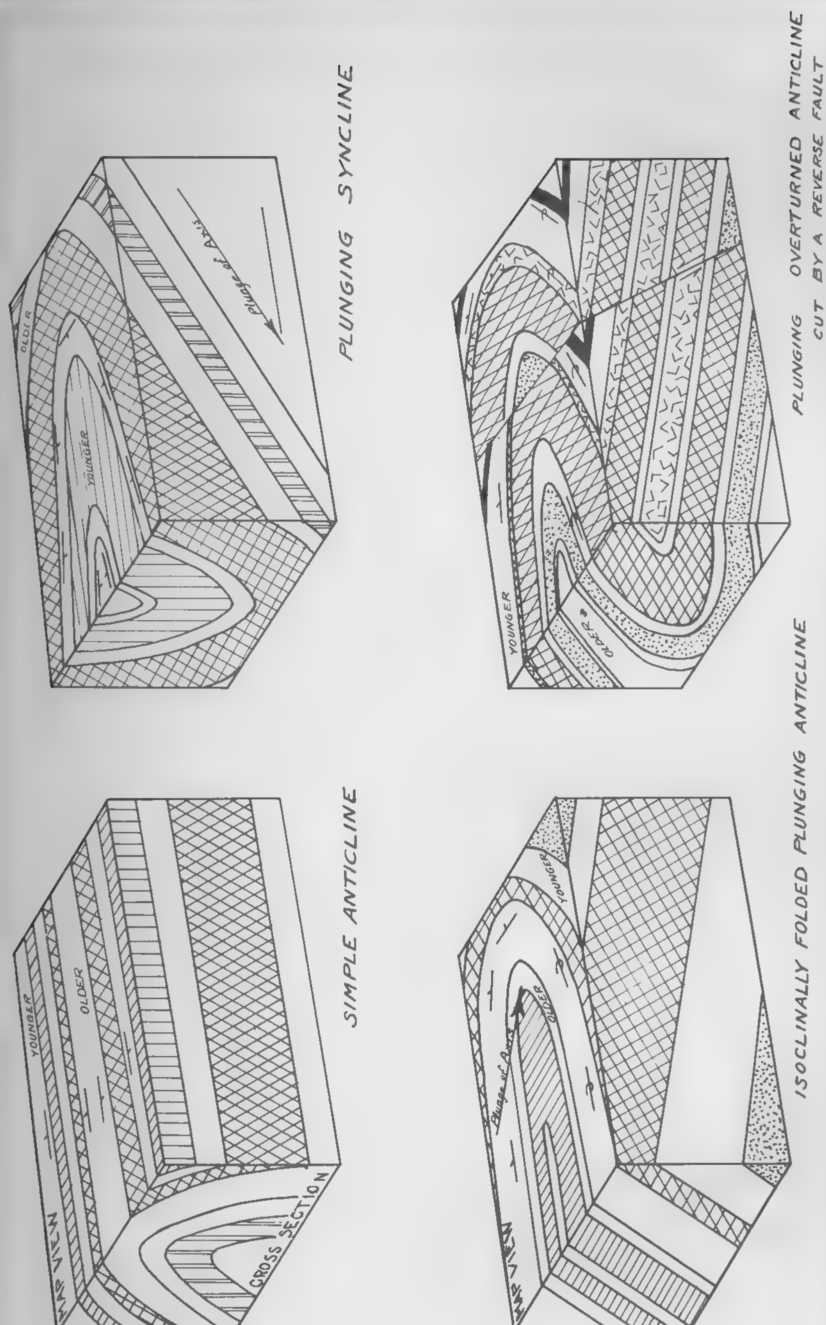
Structure

An important feature in any area is its structure: the various ways in which the rocks have been folded and broken by the forces applied to them. The two basic types of fold are named *anticline* and *syncline*. The anticline may be defined as a fold in which older rocks are enclosed by younger rocks, while the syncline is the reverse—younger rocks are enclosed by older rocks. In its simplest form the anticline has the rocks bent into an arch-shaped fold, while the syncline is trough-shaped. In Precambrian areas, where the disturbances have usually been intense, the folds may be compressed so that the sides of the fold are parallel—*isoclinal folding*—or the whole fold may be turned up on end—a *plunging* fold, or even completely overturned. This results in a very complex pattern when the outcrop of the members is traced along the surface of the ground, as is shown on a geological map.

The attitude of the various members, such as beds in sediments or flows in lavas, is shown on the geological map by *strike* and *dip* symbols. The strike is the direction of a horizontal line lying in the plane of the bed; the dip is measured at right angles to the strike and is the angle between the horizontal and the bed itself. The strike and dip are also shown for foliation in schists and gneisses, for cleavage, and for several other features, but they are usually distinguished on the map by a slightly different symbol.

There are various types of cleavage developed by the folding process, each of which has a definite relation to the fold itself; for further information on this matter reference should be made to one of the standard reference books on this subject, such as "Structural Geology" by Billings.



Block diagrams showing outcrop and sectional views of idealized folds.

Faults and *shear zones* are common structural features which are frequently of considerable economic importance. Under severe stress the rock may reach a point where it is unable to support the load, and it will break. The parts on opposite sides of the break move past one another, producing various secondary effects such as dragged beds and crushed rock, or mylonite. This frequently shows on the map as an abrupt termination of the members and their displacement laterally. If the break is sharp and narrow it is referred to as a *fault*. If the break extends through an appreciable thickness, as a series of small faults, it is called a *shear zone*, or more briefly, a "shear." One should always keep in mind that the actual displacement on the fault (known as the "net slip") may take place in any direction or even may be a rotary motion. It is thus possible for a fault with a very large net slip to show little or no apparent displacement on the map. For a complete treatment of faults and the terms applied to them, see Billings' "Structural Geology."

As faults are breaks in the solid mass of the rock, they may act as channelways along which the solutions carrying sulphides and other valuable minerals might move. It is for this reason that ore deposits are frequently found in, and alongside of, faults and shears.

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IGNEOUS ACTIVITY AND THE FORMATION OF ORE DEPOSITS

The almost universal association of deposits of the metal-bearing ores with bodies of igneous rock has led to the belief that the ore deposits are derived from the igneous rock in some way, and this belief is reinforced by the discovery of sulphides being deposited from hot springs in volcanic areas. A great many theories have been developed to explain the processes by which such ore might be formed. It is sufficient

for our present purposes to say that ore deposits are generally believed to form from the molten igneous rock either by "segregation" or by "hydrothermal action."

Magmatic segregations are thought to form by separation from the molten rock in much the same way that a sulphide matte separates from the slag in a furnace. In the case of the furnace the matte is drawn off for further treatment. In the case of the molten rock the sulphides which separate may freeze along with the rest of the rock, but as a distinct layer, or, they may be injected under pressure into any faults or fractures in the surrounding rock. The outstanding deposits of this type are associated with dark rock (such as diorites, gabbros, or norites), and are apparently restricted to a few minerals. The diamond pipes of South Africa, the platinum and chromite deposits of the Bushveld in South Africa, and the great iron deposits of Sweden are the outstanding examples. The nickel-copper-platinum deposits of Sudbury and the nickel deposits of Lynn Lake may belong to this class. The chromite deposits of Bird River in Manitoba are also thought to be of this type.

The *hydrothermal deposits* probably have a more involved history. As the molten igneous rock (*magma*) makes its way into the thick cover of country rock, it is cooled, and the minerals of higher melting point, the pyroxenes and the feldspars, begin to crystallize. As the cooling becomes more advanced, more and more of the magma becomes solidified until, finally, only a fraction composed mainly of hot water is left. It is thought that in solution in this hot water are the components of the quartz, sulphides, and other minerals which eventually form the ore deposits. This solution is usually called the ore solution or *hydrothermal solution*. While the large mass of magma was going through this cooling process, its outer parts would have frozen and become solid. But, with all the contraction and movement that would be involved in the introduction of the magma and its later cooling, this solid outer portion would be cracked and fractured. Some of these fractures would reach deep into the mass where the hydrothermal solutions would be concentrated. Under the very high pressure which must exist in depth, the water and its "dissolved" material would be forced out along these fractures into the country rock,

travelling through any faults, shear zones, or permeable areas until it eventually reaches the surface of the earth.

On its upward journey through the cold country rock the ore solution would be cooled and a point reached, eventually, where the dissolved material could no longer be held in solution and would drop out somewhere along the channelway to form an orebody (if of sufficient size.)

Further complications are due to the heating effects of the solutions on the walls of the channelway and chemical action between the solutions and the wall-rocks, with changes in both. The resulting changes in the walls are called *wall-rock alteration*. It is probably because of this interaction between wall-rock and ore solutions that certain rocks, such as the greenstones, are "favourable" and others are "unfavourable," as hosts for ore deposits.

The essential requirements for hydrothermal ore deposition are then: (1) a source of the metal in an igneous body, which may not be exposed on the surface; (2) channelways through which the ore solutions moved, such as permeable beds, faults, or shear zones; (3) a place where the ore can deposit, which may be an open space in the rock or which may be formed by reaction between the solution and a favourable rock material (replacement). The prospector should remember that some of the channelways apparently followed by ore solutions are relatively solid rock, as far as their appearance goes.

One should always remember that whereas the above outline is simple the actual process must be extremely complex; there are involved the chemical reactions between a large number of elements all in the same "pot," the most delicate balances between temperature and pressure, and all the proper conditions must be just right, at the right time, at the proper opening in a channelway, where the wall-rock does not upset the whole system again. As one geologist has put it: "The great marvel is not that ore bodies are scarce but that they should ever have formed at all. That all the proper conditions should have been found at the proper place and time is nothing short of a miracle."

The prospector should also remember, perhaps, when reading in geological publications that, though the theories on the origin of ore deposits are the result of many years of

very careful observation, and much careful thought by many people, they are still theories. A deep-seated orebody has never been seen in the process of formation, and probably never will be seen. The theories may be modified, or thrown out completely, in the light of further knowledge. Many of the theories to which there is reference in the older geological reports are now considered inadequate, so that in reading those reports considerable discretion must be used.

For those who are interested in following the matter further the following references are suggested; various classifications of ore deposits are included in these:

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(The last three assume considerable knowledge of physics and chemistry.)

Guides to Ore

Inasmuch as the visible portion of an orebody is likely to be a very small affair, compared to the expanse of the whole North country, one really needs some larger feature to search for, something a little easier to see. It must, naturally, be something closely associated with the orebody which is sought. It is essentially this idea which the prospector is following when he searches a belt of greenstone looking for quartz veins. Experience has shown that gold deposits frequently occur in greenstone belts; having found this the prospector sets his sights a little finer and looks for the smaller targets, say the presence of pyrite or other sulphides in the quartz.

There are various guides which may be of help in the search for ore, such as: (1) physiographic, (2) mineralogical, or (3) stratigraphic or lithological guides.

Physiographic Guides—Depressions and hills may serve as guides. Quartz veins may be harder and more resistant

than their surrounding rocks, and stand up as ridges. Owing to the severe glaciation of the Canadian Shield such guides are not as helpful here as elsewhere, but may still be used though the features are not as prominent. As an example, the micropegmatite which is associated with the orebodies at Sudbury forms a ridge. In other districts the softer lavas may be eroded to form depressions. Commonly also the line of a fault or shear zone may be marked by a valley or muskeg, often with an adjacent steep hill or cliff. Such faults, of course, merit investigation. The variations in the topography may reflect the variations in the rocks beneath, and may serve as rough guides to the limits of the different rock types in an area.

Mineralogical Guides—The minerals present in the rocks, and their abundance, commonly serve as important guides to ore, though, perhaps, they are often used unconsciously. Mineralogical guides that are of value to the prospector are probably limited to the effects of rock alteration and oxidation.

As was mentioned when discussing ore formation, the heat carried by the ore solutions frequently has an effect on the wall-rock, causing development of new minerals. In addition, and probably the larger effect, the solutions may, themselves, introduce minerals other than those already present. As a result, one may say that mineralogical variations in wall-rock, unless they are an essential character of the original rock mass, are usually due to alteration by mineral-carrying solutions. They merit consideration as guides to possible orebodies, for that reason, and the alteration usually forms a much larger "target" than the orebody itself. It must be realized, however, that metamorphism may alter the original character of the rock, without necessarily implying the presence of ore-solutions.

The alteration may be marked and easily seen; it may be slight and marked only by a change in color or in grain-size in the rock. The introduction of sulphur, as pyrite, is a common and well-known form of alteration. Other minerals associated with the type of orebodies common in the Shield area are: garnet (especially in limestones), amphiboles, pyroxenes, tourmaline, and biotite. Sericite, chlorite, carbonate (often as ankerite), and quartz are also common.

Chalcopyrite, sphalerite, and galena, apart from their own value, may indicate gold.

It should be pointed out that the recognition of the alteration may frequently require very close observation and mapping, and that the greatest use of the principle comes in directing development within the mine. The alteration, too, may be so widespread that it serves only to call attention to the possibility of ore somewhere within the whole district; or it may be so restricted that it forms a "target" little larger than the orebody itself.

Oxidation products may serve as a guide to the ore beneath them. In certain copper districts this has been a very valuable guide, allowing, even, a good estimate of the grade of the ore beneath them by a study of the various minerals present in the oxidized outcrop. On the Canadian Shield, where glaciation has removed all but the recent oxidation, this guide loses much of its value. (See section on Flin Flon for a description of the oxidized outcrop of that orebody.) Nevertheless, the dark-brown or yellowish "*burn*" or "*gossan*" on the rock, due to the oxidation of pyrite, is a well-known and common guide used by the prospector. It usually advertises the former presence of wall-rock alteration by pyrite or chalcopyrite.

The gossan is due to a complex chemical reaction involving the production of sulphuric acid from the pyrite. Gold, when it occurs with pyrite, commonly occurs within the pyrite itself. When the pyrite is changed to sulphuric acid and flows away into the ground water and the swamps, the gold is completely unaffected by the acid and remains behind. This results in two items of interest to the prospector: (1) Removal of the pyrite by oxidation does not mean removal of the gold; sampling the oxidized outcrop will reveal it, if gold was originally present. The absence of fresh pyrite should not induce the prospector to pass up the outcrop without examination. As the gold is now "free," panning should reveal it, if present. (2) Because the pyrite has been removed and the gold, in effect, concentrated, assays from the oxidized portion will likely show much higher values than from the unoxidized rock beneath. It is for this reason that examining engineers insist on getting samples from the fresh rock, as that is what must be mined. On the other

hand, if the oxidized portion shows little or no gold, there is little reason to believe that the fresh rock will carry higher values.

An oxidation stain, similar in its origin to the pyrite gossan, serves to show the former presence of cobalt. This characteristic "cobalt bloom" is the mineral erythrite. Because of the association between cobalt, silver, and radioactive minerals, the "cobalt bloom" may serve as a mineralogical guide to all of these. Similarly, some of the oxidation products of uranium minerals have characteristic orange and yellow colors.

Stratigraphic and Lithological Guides—In many districts certain rock types are more frequently ore-bearing than others, or are, in some way, more closely related to the ore. The association between ore and "porphyry" and between ore and greenstone, in various parts of the Shield, is well known. The presence of a rock type known to be "favourable" as a host for ore may serve as a valuable guide in the search for orebodies. In a new district, of course, this aid is of much less value than in an established district where the habits of the ore are known, though the reasons may not be. In this case, the prospector's best plan would probably be to follow such indications as the new district affords. For example, in the vicinity of Sickle Lake there are scattered showings of gold. The rocks of the area include metamorphosed volcanics, arkose and quartzite, diorite and granite. The sulphide minerals occur only in the volcanics and in the diorite, with the best gold values in the diorite. As a prospecting plan then, it would seem logical to prospect the diorite areas first, and then the areas of volcanics, searching for such shear zones, sulphides, etc., as may offer additional guides.

The following remarks on favourable host rocks apply more specifically to Manitoba than have some of the foregoing:

The known mineral deposits of importance are in volcanics and associated rocks, sedimentary gneisses, intrusive bodies of quartz gabbro, and granodioritic phases of the granitic intrusives. So far, the thick-bedded arkose and conglomerate beds have not been proved to carry deposits of merit. The sulphide and quartz bodies are in chloritic and

sericitic schists produced by shearing in acidic and basic lavas, and also in bedded tuffaceous layers. *In prospecting, the wide schistose zones should first be located and subsequent work limited to a detailed exploration of the belt of deformed rock.* Many of the schist zones follow lake basins or swampy depressions for a large part of their length; consequently, many of the deposits discovered to date are located along or near lake shores.[1]

As regards gold, the occurrences in western Ontario and northeastern Manitoba indicate that the majority of the discoveries are in basic lava, only a few discoveries being in acid lava, sediments, granite, quartz porphyry, diorite, and gabbro. Many deposits, however, are in schists, derived from basic lava, that are cut by dykes of quartz porphyry, or these dykes occur nearby. *The association of gold-bearing quartz and dykes of quartz porphyry is widespread and, hence, all schist zones cut by dykes, and especially by quartz porphyry should be prospected very closely. The wide brecciated and silicified zones should be investigated thoroughly.*[2]

According to C. W. Knight: "The great gold mines of Central Canada occur along, or near, narrow belts of closely folded sediments, these belts resting on a basement consisting of basic lava flows of stupendous thickness belonging to the Keewatin series. . . . *They are practically all associated with intrusives of "porphyry,"* such as feldspar porphyry, quartz porphyry or syenite porphyry. . . . As a general rule the sediments are characterized by the presence of coarse boulder conglomerate with which are associated greywacke, quartzite and slate. The beds are nearly always resting in more or less vertical attitudes."[3]

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3. "Central Canada's Gold Belt;" Can. Min. Jour., vol. 54, pp. 98-101, March, 1933.

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THE INTERPRETATION OF A GEOLOGICAL MAP

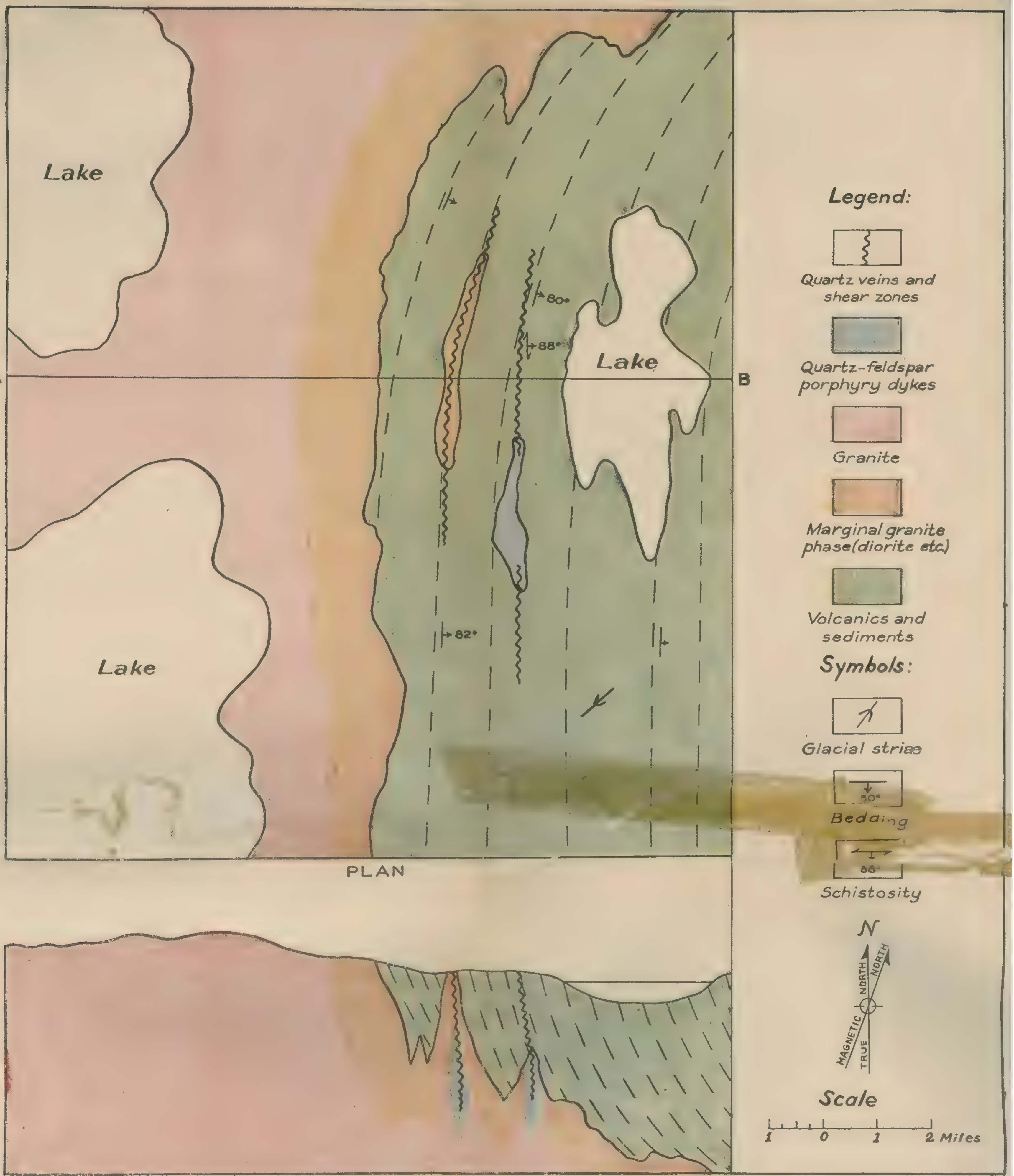
The following description of a favourable geological setting for an ore occurrence may prove to be of assistance to prospectors who are not particularly familiar with the interpretation of geological maps. In addition to indicating the topographical features of an area, geological maps show the variety of rock types occurring in an area by means of a legend. The legend may be shown on the map by the use of various colours or, in some cases, by the use of a significant pattern. As colouring shows up rock pattern much more clearly, it would be wise for prospectors to colour any maps they may possess, instead of using a pattern.

What the Legend Means

The legend is always given with a geological map, and it indicates, in addition to the rock types, the age relationship of one rock type to another. As may be seen in the plate facing this page, the volcanics and sediments are the oldest rock forms and so are placed at the bottom of the legend. Think of rock types on a legend as you would a pile of blocks, the bottom blocks being the first ones to be placed in position.

Structural Symbols

Certain symbols appear on geological maps to indicate the attitude of the major rock forms. These symbols are useful for interpreting rock structures and relationships over wide areas. Their meaning is usually explained by a list of symbols which accompanies the map legend. Symbols of strike and dip are the most important. Strike indicates the direction of alignment of a rock formation, measured on the horizontal plane. Dip is measured in a direction at right angles to the strike, in the vertical plane. It will be seen on the plate facing this page, that one of the shear zones strikes at a slightly different angle from that of the bedding of the rock, and also dips eight degrees steeper. Such structures are worthy of note, as they may indicate a persistence to the shear zone bearing ore minerals.



SECTION ALONG LINE A-B OF PLAN

IDEALIZED PLAN AND SECTION OF A GEOLOGIC SETTING FAVOURABLE FOR ORE DEPOSITION

All this took place far below the surface of the earth, and these deposits were formed at a depth of several thousand feet. Erosion over much of the geological past has, however, levelled the folds that formed the mountainous ranges so that the rocks which are now exposed at the surface are the remnants of rocks, older than the granite, which have been engulfed in it. The tops of some of the original ore deposits may have been removed, or possibly whole orebodies. This does not imply that orebodies as they now exist will not continue to great depth.

NOTE

A glossary, to which the reader is referred, is appended to this publication for the use of any to whom some of the rock and mineral terms may be unfamiliar. See pages 147 to 153.

PART III

MAP SHOWING
PRECAMBRIAN MINERAL AREAS OF MANITOBA

MINERAL AREAS

The mineral areas which are described in the following pages receive their names from some lake, river, or other prominent topographical feature within each locality. They are localized areas of Precambrian lavas and sediments in the much larger masses of granite, granite-gneiss, and granite-like rocks that occupy the Precambrian Shield. Many metalliferous deposits have been discovered in the better-known areas, but large stretches of favourable territory which have been explored only to a limited extent still await the prospector. Districts which have been intensively prospected in the past are still yielding deposits of merit, a case in point being the Bird River chromite which was not discovered until 1942.

The problem of correlating areas of Precambrian rocks which are separated by wide intervening stretches of granite is one of the most difficult tasks in geology, and for this reason it has been the custom of geologists who have mapped the different areas to apply local names to the strata occurring in each area. Hence, there appears to be the same type of volcanic rocks variously named as Hayes River group, Kiski volcanics, Amisk volcanics, Wasekwan series, and Rice Lake group according to the areas in which they occur. Similarly, beds of sediments which may or may not be related are named Island Lake sediments, Oxford sediments, Missi sediments, Sickle series, and San Antonio formation in the different areas. The large area of altered sedimentary rocks extending from the Manitoba-Saskatchewan boundary east through Kississing and Loonhead Lakes to Herblet Lake and beyond are known as the Kisseynew gneisses.

BOUNDARY AREA

The Boundary area includes that part of southeastern Manitoba which lies along the Manitoba-Ontario boundary between the Canadian Pacific railway and the Greater Winnipeg Water District railway. The area has been extended westward to Rennie to take in the radio-active pegmatites. Most of the mineral deposits are in townships 8 and 9, range 17, east of the Principal meridian. As this area forms part of the Whiteshell Forest Reserve, claims may

only be staked and recorded in accordance with section 12 of the Regulations for the Disposal of Mining Claims, as well as with requirements of the Forest Act. The area contains West Hawk, Falcon, and Star Lakes and may be reached conveniently by the Trans-Canada Highway.

General Geology

The rocks include basic to intermediate varieties of lavas which are massive, schistose, or pillowed, as well as some fragmental types. Sediments are usually fine grained micaceous, and quartzose, with some zones of conglomerate. These rocks have been invaded by a number of granitic magmas. There is a similar assemblage in Ontario in the Lake of the Woods country where the volcanic-sedimentary series was called Keewatin by Lawson. In the Boundary district this series forms a band from the north side of Falcon Lake to the north side of West Hawk Lake. This band narrows considerably to the southwest. Another zone of Keewatin-type rocks cuts through Indian Bay in Shoal Lake but is lost in muskeg a short distance to the west.

Most of the mineral deposits occur in the volcanics and sediments, and it has been noted that there seems to be a progressive gradation in mineral types as the granite is approached.

Pegmatites are prominent, particularly in a belt which strikes northeast along the western side of the main band of volcanics and sediments where these rocks are in contact with the large granite area to the west. Dykes occur in the granite itself, but those of economic importance are in the Keewatin-type rocks, commonly within a few hundred feet of this granite contact. They are mostly tabular bodies from 2 to 10 feet wide and most are parallel to the schistosity of the surrounding rock.

Mineral Occurrences

Molybdenite is the only prominent metallic mineral in the pegmatites. It occurs commonly as crude crystals up to 3 inches in width. The massive, fine-grained variety is less abundant. The principal occurrences are in dykes in schist about 2 miles north of the west end of Falcon Lake. Fine-

grained disseminated molybdenite occurs in a group of parallel stringers of quartz at the east end of Falcon Lake on both sides of the interprovincial boundary.

Scheelite has been found in small quantities in lenticular shear zones that average 2 feet in width and 25 feet in length between Barren Lake and West Hawk Lake, to the north of the molybdenite pegmatites. The scheelite is either associated with quartz or amphibolite. Associated minerals are epidote, brown garnet, and calcite. There was a revival of interest in these deposits during World War II, and a number of new discoveries were made. Scheelite ore from the most promising occurrences was shipped to the Bureau of Mines at Ottawa for testing. It was found that the material had too low an average grade to be commercial.

Noteworthy amounts of spodumene with some crystals of beryl occur in lenticular pegmatite masses near the westerly tip of the Falcon Lake greenstone belt, a short distance northeast of Glenn station on the Greater Winnipeg Water District railway. Near the south shore of West Hawk Lake there is a small occurrence of lithia silicates, lepidolite and spodumene, in a pegmatite body.

Radio-active pegmatites occur in a belt extending along the Trans-Canada Highway from Rennie to Caddy Lake. The pegmatites occur in a zone between porphyritic granite to the south and gneissic granite to the north. Radio-activity is usually confined to a narrow band of pegmatites associated with metamorphosed sediments and volcanics near the contact with porphyritic microline granite. Recent assays have ranged from 0.01 to 0.70 per cent U_3O_8. Uraninite, uranothorite, cyrtolite, monazite, and allanite have been reported from this locality.

Tin was discovered in 1914, in a sulphide zone that outcrops on the east shore of West Hawk Lake. The tin-bearing mineral there resembled chalcopyrite, and assays yielded from 0.18 to 0.30 per cent tin. The distribution of the tin-bearing mineral was irregular, however, and recent investigators have been unable to find tin in the original pits.

A notable feature of the area is the occurrence in the schist of large sulphide zones, some of which extend over several claims. These zones are found on both sides of West Hawk Lake, in the Star and Falcon Lakes areas, and several

miles to the west of Falcon Lake. Pyrrhotite and pyrite are the predominant sulphides, with some chalcopyrite, sphalerite, and galena. Gold, silver, and nickel values are usually very low.

Gold-quartz veins have been found in several places. Gold values are known in a silicified shear zone near the east end of Falcon Lake. Gold occurs associated with arsenopyrite in a small quartz vein just north of the Goldbeam Mine, and several other small gold deposits are known between Falcon Lake and West Hawk Lake.

The largest venture of the district was that carried on at what was the Sunbeam-Kirkland Mine; Goldbeam Mines Limited later acquired this property. Considerable underground development was done on a pipe-like gold deposit which occurs in a highly fractured and hydrothermally altered phase of the Falcon Lake composite stock. Ore solutions rising through closely spaced fractures have altered the country rock and deposited quartz, pyrite, pyrrhotite, sphalerite, chalcopyrite, galena, tetrahedrite, and considerable amounts of free gold. Much of the free gold is found in the late fractures and openings that cut the quartz and sulphides, but its distribution is erratic. The deposit is elliptical in horizontal cross-section and has an average area of roughly 2,500 square feet. The main axis of the pipe plunges 65 degrees in a direction north 30 degrees west. The major development of this deposit was done between 1937 and 1940, and operations were suspended in 1946.

The Memorial Marble and Tile Company of Winnipeg operates two quarries in the district. Grey granite is taken from a quarry beside the Trans-Canada Highway west of Hawk Lake, and black diorite is quarried on the Fortune mining claim, just west of the Falcon Lake road, on the north side of the Falcon Lake stock.

The Shoal Lake Granite Company works a black diorite quarry northeast of Glenn. This rock is used exclusively for monuments, and the stones are finished at the quarry.

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WINNIPEG RIVER AREA

The Winnipeg River area comprises the country bordering Winnipeg River from Pointe du Bois east to the Manitoba-Ontario boundary. Pointe du Bois, the point of entry into the area, is located on Winnipeg River 20 miles due east of Lac du Bonnet from which point it is easily reached by motor road or railway. The river is navigable to canoes and motor boats from Pointe du Bois eastwards.

General Geology

The sediments and volcanics of the Rice Lake group are the oldest rocks. The major intrusives comprise granite

masses of several compositional types which may be the result of a single period of magmatic activity.

A microcline granite is the most widely distributed rock, and it extends across the middle of the area for a length of 60 miles. Near the inter-provincial boundary it has a width of 27 miles. This granite is generally uniform over great distances and is characteristically massive.

Oligoclase granite, granodiorite, and quartz diorite occur over much of the area, but the continuity is interrupted by microcline granite. Composition, colour, texture, and structure vary over short distances. The contact between the different types is indefinite. South of Winnipeg River the microcline granite has intruded the others to form a wide mixed zone.

Two main types of albite granite are recognizable, varying in colour from white to pink. Mineralogically they are albite-muscovite and albite-tourmaline granite, the former usually containing small amounts of biotite. These granites occur intrusive into a belt of pillowed volcanics south of Winnipeg River.

Minor intrusives include dykes of granite, aplite, and pegmatite, as well as lenticular bodies of pegmatite. The dykes vary in size up to 100 feet wide and several hundred feet long. Commonly they are from 2 to 10 feet wide and have straight vertical walls. Close to the borders of the larger masses of albite granite are a few dykes of the same rock, as well as albite aplite, albite pegmatite, microcline pegmatite, and many dykes that are a mixture of microcline pegmatite with one of the types just mentioned. The lithium-bearing masses appear to be phases of the albite pegmatites.

Mineral Occurrences

Lithium Deposits—The discovery of a deposit of lithium minerals on the Bear claim (now called Bob) in 1924 attracted attention to the Winnipeg River area as a possible source of lithium. Other deposits were discovered during the following two years near Winnipeg River and at Bernic and Cat lakes to the north.

The Bob claim lies 3 miles southeast of Lamprey Falls on Winnipeg River. This deposit was taken over by the Silver

Leaf Mining Syndicate (Canada) Limited in the early days, and considerable development work was done. Small shipments were made to the United States, England, and Germany prior to 1929 for quantity sampling and experimental work. The pegmatite is a zoned trough-shaped body. Lithium-bearing minerals include lepidolite, spodumene, amblygonite, and zinnwaldite.

Other claims in this vicinity with minor quantities of lithium minerals are Annie, Gray, and the old Captain group.

Lithium-bearing dykes occur over an area 500 feet wide and 3,000 feet long near the east end of Bernic Lake. The chief of these is on the Buck claim, about a quarter of a mile from the Lake, where a complex zoned sill-like body has been exposed. Black tourmaline forms a thick band at the top. Silicates and phosphates of lithium including spodumene, amblygonite, triphylite, and lepidolite occur mainly in a quartz zone which probably forms the central part of the sill. Other pegmatite and quartz bodies near the sill contain scattered large amblygonite crystals. A small pit at the lake has uncovered an almost pure concentration of petalite.

In lithium-bearing pegmatites, ablite predominates over microcline and is usually of the cleavelandite variety. Quartz and muscovite are major constituents. Tourmaline, garnet, apatite, beryl, topaz, fluorite, tantalite-columbite, monazite, and calcite are locally present.

Prospectors in search of lithium deposits should keep in mind the relation of lithium pegmatite to the major granitic intrusives. Search should be made in areas of sediments, volcanics, and oligoclase granite close to the edges of intrusions of albite granite. Albite granite is not exposed at the surface in some areas, but its presence close to the surface may be indicated by a group of albite-bearing dykes. Lithium deposits are not likely to occur within intrusions of microcline granite or in areas of oligoclase granite, sediments, or volcanics which contain numerous dykes of microcline granite, microcline aplite, or microcline pegmatite.

Beryllium Deposits—Beryl occurs in pegmatites mainly in the same localities and even in the same deposits as the lithium minerals.

South of Winnipeg River the Huron claim contains a noteworthy concentration of golden beryl as well as large

crystals of pale green beryl. A number of claims in the vicinity of the Huron contain smaller amounts of beryl. Most of the beryl-bearing pegmatites are within volcanics, but one cuts the albite granite intrusion to the north.

There are numerous small beryl pegmatites to the west, south, and east of Greer Lake. Beryl is the only rare-element mineral of importance in these bodies which intrude granodiorite. The mineral occurs in green crystals as much as 1 foot in diameter. Small aquamarines are present in one dyke.

North of Winnipeg River large white beryl crystals have been found in and around the Buck claim lithium deposit. A few tons of white to colourless beryl were taken from a dyke on the north shore of Bernic Lake near the Consolidated Tin Corporation shaft.

Pegmatites containing white to yellowish beryl have been found on the south shore of Shatford Lake. Small blue beryl crystals occur in the cassiterite pegmatitic on Tin Island in Shatford Lake.

All these dykes have been explored to some extent. Many of them present an economic problem in that beryllium is the only rare element carried.

Tin Deposits -Dykes of albite pegmatite containing cassiterite have been known in southeastern Manitoba since 1924 when the mineral was discovered at Shatford Lake on Tin Island. Only a few square feet of this dyke were visible above water, but after further exploration in the vicinity, the Manitoba Tin Company Limited decided to sink a shaft on a larger island to the east of the discovery. Drifting along the dyke showed that the tin content was not commercial and the project was abandoned.

Consolidated Tin Corporation Limited (Jack Nutt Mines Limited) sank a shaft on the north shore of Bernic Lake in 1929 to explore a cassiterite showing in a system of low-dipping pegmatite bodies. These pegmatites underground were disappointing in their tin content.

Sporadic occurrences of cassiterite have been found as far south as the Annie claim south of Winnipeg River.

Nowhere in the world have pegmatites been important sources of tin ore. The sources of lode tin are quartz veins carrying cassiterite and such characteristic minerals as topaz,

fluorite, and tourmaline. Near these veins the country rock is altered typically to a quartz-muscovite aggregate known as *greisen* which is formed mostly at the tops of batholiths. Erosion has been carried below the greisen zone in the exposed granite areas of Manitoba. About two-thirds of the world's supply of tin is now won from placer deposits.

Radio-active Deposits—The Huron claim is famous for its radio-active minerals including uraninite, monazite, and columbite-tantalite. Age determinations made on the uraninite and also on lepidolite from the old Bear claim indicate that this region is one of the oldest parts of the earth yet recognized. An age of at least 2,100 million years is indicated. The east end of the Huron sill is very radio-active over an area of about 25 square feet.

Close inspection of the Winnipeg River area shows that radio-active minerals are present in a number of other dykes. The Bob (Bear) lithium deposit contains a narrow veinlet of radio-active material. A few reddish-brown crystals of a complex mineral have been found in the feldspar quarry at the east end of Greer Lake. One of the beryl dykes at Shatford Lake has some crystals of a mineral that probably belongs to the euxenite-polycrase group. However, as is usual with pegmatites, these minerals are erratic in occurrence.

Feldspar Deposits—Feldspar is plentiful owing to the profusion of pegmatite dykes. Some dykes contain almost pure feldspar with very little quartz. Microcline and albite feldspar of ceramic grade was quarried from a large body at Greer Lake between 1933 and 1939, during which time 5,400 tons were shipped. The ore was barged the 12 miles to Pointe du Bois and then shipped by rail to Feldspar Products Incorporated at Warroad, Minnesota.

In 1930 some 600 tons of low grade feldspar were shipped from a quarry 3 miles east of Pointe du Bois on the north side of Winnipeg River. This was used for stucco and similar purposes.

Fuchsite-bearing Rock—Fuchsite or chromium mica occurs in quartzite in the southwest part of section 13, township 16, range 15, east of the Principal meridian. A road, three-quarters of a mile long, furnishes access to Winnipeg River, from which point it is 6½ miles by water to the railroad

connection at Pointe du Bois. In 1926, 150 tons were shipped to Winnipeg for use as stucco dash.

The fuchsite occurs in a narrow band of quartzite bordered on its south side by oligoclase granite and on its north side by basaltic lava. The quartzite contains a pale green bed about 3 feet wide, in which the fuchsite occurs in lenses measuring up to 3 feet by 1 foot. The fuchsite has a bright green colour and is schistose. It has probably been formed by metamorphism of original constituents of the quartzite.

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OISEAU (BIRD) RIVER AREA

The Oiseau River area lies along Oiseau River between Lac du Bonnet and the Manitoba-Ontario boundary. The river, except for a few short portages, is easily navigable throughout its length in Manitoba. A graded road, following on the north side of the river, extends approximately 12 miles northeast from Bird River post office towards Oiseau Lake.

General Geology

The rocks may be conveniently subdivided into two groups, namely the Rice Lake group of very ancient origin and a younger group of intrusives. The Rice Lake group is composed of sediments and volcanics. The Bird River sill was introduced into these rocks while they were still flat-lying. These two groups were later folded and then intruded by granitic types of varying composition. It has been concluded that the dominant structure is anticlinal. The Bird River sill and the Rice Lake group may be seen to form the south limb of the structure in the Oiseau River area and the same series of rocks outcrops as the north limb of the anticline in the Maskwa Lake-Cat Lake district. Both limbs dip at high angles and converge to the east.

Mineral Occurrences

Copper-Nickel Deposits.—Copper-nickel sulphides were discovered west of Oiseau Lake in 1920. The minerals occur in members of the Rice Lake group and the Bird River sill near granite contacts. The mineralized zone extends from about 2 miles west of Oiseau Lake intermittently along the contact of the granite with the earlier rocks for a distance of some 2½ miles to the west. Pyrrhotite, pentlandite, and chalcopyrite are the ore minerals. They may not all occur in a single body, and some deposits are nickel-free. Pyrite, cubanite, and titaniferous magnetite may be locally abundant. Galena, sphalerite, silver, gold, and traces of cobalt have been found.

The sulphides are found mainly on the Chance, Devlin, Martin Fraction, Wento, Colossus 3, and Colossus mining claims.

The most easterly showings are those on the Chance. Pyrrhotite, pentlandite, and chalcopyrite are exposed in a number of trenches for a length of 800 feet and a width up to 40 feet. Two shallow shafts were sunk on the property in addition to a number of drill holes. The host rock is a fine-grained andesite and a coarse-grained hornblendic rock, which may be a phase of either the Rice Lake group or the Bird River sill. Granite lies immediately to the north of the trenches. Wright reported average assay results of 1.95 per cent nickel and 0.15 per cent copper.

The Devlin orebody overlaps into the Martin Fraction. Geological conditions are similar to those on the Chance. The oxidized sulphide zone is 20 to 40 feet wide and contains nickeliferous pyrrhotite, chalcopyrite, and magnetite. Assays indicate from 1 to 3 per cent copper and 0.5 per cent nickel.

The Colossus 3 deposit is of smaller extent and contains chalcopyrite as well as minor amounts of galena, sphalerite, silver, and gold.

The Wento orebody is 300 feet long and a maximum of 100 feet wide. The sulphides occur in andesite which is surrounded by granite to the north and west and gabbro to the south and east. Pyrrhotite, chalcopyrite, and titaniferous magnetite are more massive than in most other places in the area. Assays of more than 5 percent copper were reported from a shaft that was sunk in the centre of the zone.

Three trenches on the Colossus claim contain sulphides, mainly chalcopyrite, for a distance of 130 feet in a northerly direction and across a width of 100 feet. The host rock is mainly tuffaceous sediment. The copper content ranges from 1.5 to 4.1 per cent.

Wright concluded that there were probably two periods of mineralization, the first associated with the intrusion of the Bird River sill and characterized by the presence of copper and nickel, and the second associated with the intrusion of granite and characterized by the presence of copper without nickel. Interest has revived in these deposits in recent years and the nickel companies have had geophysical and geological parties in the area.

Chromite Deposits—The largest mineral deposits of this part of Manitoba were discovered in 1942. They have been formed by chromite segregations in the Bird River complex,

Glacial grooves and striations on peridotite near scene of subsequent chromite discovery, Bird River. R. W. Sweezy, prospector (lower left)

a folded basic and ultrabasic sill composed of gabbro and peridotite. These rocks outcrop intermittently north of Oiseau River from the east end of Lac du Bonnet to the west end of Oiseau Lake. The sill varies from 500 to 3,500 feet in thickness with the peridotite underlying the gabbro. The chromite includes dense and disseminated ore. It is found as bands and stringers in the peridotite within 170 feet of the gabbro contact. Faulting, usually of relatively small displacement, has disrupted the continuity of the bands. The principal deposits occupy a zone of several alternating layers of dense and disseminated chromite across a width of about 8 feet. The mineral is in the form of tiny black, metallic or resinous octahedra set in a chloritic or amphibolitic groundmass.

The average tenor of the main chrome band is from 18 to 26 per cent chromic oxide which can be raised by table concentration to a product containing 35 to 42 per cent chromic oxide, and having a chrome-iron ratio between 1.2:1 and 1.5:1. The grade and quality of the concentrates is not sufficiently high to meet present specifications of the users of metallurgical chrome but large reserves of chromite are available when techniques make possible the utilization of material of this grade. The ore deposits should continue to depth as they are regarded as primary segregations in an originally horizontal body.

Tin Deposits—The area west and north of Rush Lake, just south of Oiseau Lake, has been carefully prospected for tin. Pegmatite dykes containing cassiterite range from a few hundred feet to more than one-quarter of a mile in length. Cassiterite of erratic distribution is characteristically associated with quartz-muscovite phases on the hanging-walls of the pegmatites. The mineral was deposited in small crystals of more uniform distribution in fine-grained albitite dykes associated with the pegmatites. After a drilling program was initiated in 1942 to explore further the possibilities of these dykes, it was concluded that the tin content was not high enough to be of commercial value.

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CAT LAKE-MASKWA LAKE AREA

This area lies 10 to 15 miles north of the Oiseau River copper-nickel deposits. Access by ground to the western part of the district is difficult because the small streams are not navigable. Light planes can land on most of the lakes and air service is available from Lac du Bonnet. The graded road from Bird River post office terminates 6 miles southwest of Cat Lake.

General Geology

The geology is similar to that in the Oiseau River district. The Rice Lake group is represented mainly by volcanics with some sediments. The Bird River sill outcrops north of Maskwa Lake and southeast of Cat Lake at Euclid Lake. It bears a mirror image relation to the Oiseau River section,

that is, gabbro lies to the north of peridotite in the north-dipping sill. Granites and associated granite gneisses are the predominant rocks, and these younger types have interrupted the continuity of the older types.

Mineral Occurrences

Copper-Nickel Deposits—Copper-nickel deposits consisting of pyrrhotite, pentlandite, and chalcopyrite were discovered 5 miles north of Maskwa Lake in 1917. The deposits lie on the south side of the north limb of the Bird River sill. They are associated with the sill and also with volcanics of the Rice Lake group. The sulphide minerals form replacement bodies in both of these rock types. Pyrrhotite, pentlandite, and chalcopyrite were deposited in that order. A small amount of titaniferous magnetite is also present.

The largest visible sulphide deposit outcrops on the Mayville claim, which was the original discovery. Trenching has exposed the body for 200 feet in a northeasterly direction along the strike. Exploration also has been carried on by diamond-drilling. The two narrow disseminated sulphide zones give assay results for both copper and nickel. The south trench contains up to 50 per cent pyrrhotite and chalcopyrite for short distances. The general tenor of the deposit averages slightly more than 1 per cent copper and between 0.40 and 0.80 per cent nickel.

Another sulphide body, exposed on the Hititrite claim, contains copper, nickel, and a trace of platinum. The deposit has an exposed length of 125 feet and is from 10 to 20 feet wide. Assays run at the time of the discovery range from 0.27 to 3.23 per cent copper and from 0.19 to 1.68 per cent nickel, with one sample giving 0.03 ounces of platinum a ton.

Other smaller deposits of this nature are known. Surface work such as trenching and drilling was abandoned in 1929 but since that time magnetometer surveys have been used to outline the known deposits and also to discover other magnetic bodies.

A north-trending zone of sulphides containing chalcopyrite and pyrrhotite has been located about 1 mile west of Cat Lake on the Eagle group of claims. The minerals form

disseminated replacements in basalt. Diamond-drilling has indicated that the sulphides persist to a depth of at least 750 feet.

These occurrences have been re-examined recently by ground parties, and the airborne magnetometer has been used as a reconnaissance tool over the whole potential sulphide zone north of Oiseau River.

Chromite Deposits—Chromite is sporadic in occurrence on the north flank of the Bird River sill, in sharp contrast to the more extensive outcrops along Oiseau River. Only small deposits can be located and they are always in close proximity to gabbro.

The gabbro-peridotite contact is exposed at the northern junction of the Pronto and Colossus 24 mining claims. The relations are somewhat obscure as chromiferous peridotite and gabbro alternate for a distance of more than 200 feet south of the uniform gabbro. Both dense and disseminated chromite are present.

A band of peridotite containing dense chromite, 150 feet long and 12 feet wide, is located in gabbro on Colossus 22 claim. The gabbro is sheared for a few inches on either side of the band, giving the impression that post-intrusive movement has shifted the upper part of the peridotite into the gabbro.

Chromite has not been discovered between the last-described deposit and the east end of Euclid Lake, where the gabbro-peridotite contact lies beneath a small stream that flows into the lake. On the south side of the stream chromite-bearing peridotite abuts against granite which has destroyed the lower part of the sill. Disseminated and dense chromite may be seen in the few feet of peridotite exposed. Gunnar Gold Mines, Limited reported that they intersected a wider chromite zone in their diamond-drilling.

Gold Deposits—Gold, associated with sphalerite and galena, was discovered between Maskwa Lake and Little Bear Lake in 1924. The mineralization is localized along a number of sheared lamprophyre dykes which are cut irregularly by quartz veins. The gold occurs in the native state and as tellurides, or is intimately bound to sulphides. Most of the orebodies are small and the assays are variable from very low to very high.

Spodumene Deposits—A number of spodumene and beryl pegmatites are located near Cat Lake cutting volcanics and oligoclase granite.

A vertical dyke, as much as 24 feet wide, has been exposed for over half a mile on the Eagle group of claims. White to green spodumene is fairly evenly distributed throughout the dyke. Much of the spodumene is intimately associated with quartz, a characteristic which is prevalent in most of the dykes. The mineral is fine to coarse grained but does not occur in crystals of large size. This dyke also contains a small percentage of beryl. Northern Chemicals Ltd. reports that exploration by diamond-drilling and bulk sampling has indicated a grade of 1.40 per cent lithia (Li_2O) to a depth of 200 feet.

The same company controls a dyke on the F.D. 5 claim. This dyke differs from the Eagle in that many of the minerals are very coarse grained. Apple-green crystals of spodumene up to 2 inches in length make up 50 per cent of the pegmatite in places.

Another large dyke, a quarter of a mile long and up to 60 feet in width, cuts across the Irgon claim. The mineral assemblage is similar to that in the Eagle dyke.

A zoned pegmatite sill containing spodumene has been opened up by a deep trench on the Central claim half a mile south of Cat Lake. In addition there are a few smaller dykes in the vicinity carrying both spodumene and beryl.

The only other spodumene-bearing dyke of interest in this area is one on the Spot group of claims north of Maskwa Lake.

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BERESFORD-RICE LAKES (CENTRAL MANITOBA) AREA

The Beresford-Rice Lakes (Central Manitoba) area is probably the best known and most important gold quartz area so far discovered in the Province. It extends along Wanipigow (Hole) and Manigotagan (Bad Throat) River systems from Lake Winnipeg east to the Manitoba-Ontario boundary line. The centre of the district is about 100 miles northeast of the city of Winnipeg.

The closest rail points are Pine Falls on the Canadian National Railway and Great Falls, via Lac du Bonnet on the Canadian Pacific Railway, from which winter roads, 40 and 55 miles, lead to the San Antonio mine, and to the Long and Beresford lakes areas respectively. Air service to the area is maintained throughout the year from Winnipeg and Lac du Bonnet. This service is interrupted only for a short period during freeze-up and break-up each year, but telephone communication direct from Winnipeg is rarely interrupted.

Means of access to the area in summer, other than by plane, is by boat from Winnipeg. A bi-weekly service is maintained. The route follows Red River to its mouth, thence across the southern end of Lake Winnipeg to Manigotagan, Lake Winnipeg. This is followed by a 7-mile portage by truck to Hole River. The journey is then continued by water 20 miles upstream to Government Landing on Hole River. A motor road connects this point with Quesnel (Caribou) Lake, 17 miles distant to the southeast, where travel is continued by water to the eastern part of the area.

At about Mile 5 on the road, a short branch road leads east to Rice Lake on the north shore of which is located the San Antonio mine. Most of the development work in the San Antonio area may be readily reached from this road. From the San Antonio mine a motor road 14 miles in length may be followed to Wallace Lake.

On the route east from Quesnel Lake a tracked portage one mile in length must be crossed to reach Long Lake. A motor road leads from the east end of Long Lake northeast 4 miles to Wadhope. A side road, 4 miles to Beresford Lake, branches to the east at a distance of 2 miles from Long Lake.

General Geology

The bedrock of the Beresford-Rice Lakes area is of Precambrian age and is divisible into:

1. Volcanic and sedimentary strata of the Rice Lake group.
2. Intrusions ranging in composition from granite to peridotite.
3. Quartzite and conglomerate of the San Antonio formation.

The volcanics of the Rice Lake group range from rhyolite to basalt, with porphyritic and fragmental phases. The acid to basic flows are interbanded with pyroclastic rocks and sediments. The sediments, consisting of arkose, conglomerate, quartzite, slate, and tuff occur in bands in apparent conformity with the volcanic rocks.

Intrusive rocks ranging from granite to peridotite occur within the area. The basic varieties are considered to be

older than the acid ones, and the two types are associated with separate periods of igneous activity.

Stockwell has assigned the name San Antonio formation to a younger group of sediments. Quartzite, feldspathic quartzite, and conglomerate, characterized by low dips, unconformably overlie the rocks of the Rice Lake group and the granitic rocks.

The Rice Lake group has been folded into east-trending structures. Most dips are greater than 60 degrees. Folds within the granite gneisses are parallel with those of the rocks of the Rice Lake group. The San Antonio formation was folded during a period of deformation later than that responsible for the folding of earlier rocks.

Schistosity is widespread in the Rice Lake group, and shearing and fracturing are also well-developed. Most of these shear and fracture zones contain vein quartz, some of which is gold bearing. Faults, shear zones, and schistosity are usually lacking in the San Antonio formation.

Wright says of the area:

"The gold deposits are quartz bodies of variable size occurring along shear zones within members of the Rice Lake series and certain of the bodies of granitic rocks cutting this series. Narrow, jointed and schistified zones carrying small

Typical folded shear zone, Rice Lake area.

bodies of quartz are widespread, especially in the volcanic members of the Rice Lake series, whereas, apparently, at only a few localities are large shear or fault zones developed. Some of the large, persistent shear zones do not contain quartz and others carry large bodies of quartz that is not gold bearing. Free gold in quartz, however, is widely distributed. . . . Many of the shear and fault zones and their enclosed quartz bodies are located along structural features such as the contact between lava flows or the contact between a lava flow and chert, tuff, or quartzose sediments, or the contact of small, intrusive bodies with lava or sediment."

Zones of deformed rock follow closely the dip and strike of the schistosity and the bedding of the enclosing rocks; the angle between the average trend of a shear zone and the strike of the schistosity or bedding of the country rock is in no case over a few degrees. *The best conditions for the formation of large bodies of quartz, however, seem to occur where the shearing makes this small angle with the surrounding rocks.* See Idealized Plan and Section, facing page 42.

The quartz bodies are divisible into the following four types on the basis of colour, texture and mineral content:

1. Dark, smoky, medium-grained quartz;

2. White, medium-grained quartz associated with abundant carbonates;

3. White, finely crystalline, sugary quartz;

4. White, coarsely crystalline, pegmatitic quartz carrying albite feldspar.

Of these four types, *the first three are considered the most valuable and the orebodies at present under development consist of these types of vein material.* In much of this ore the gold is not visible to the naked eye. A few bodies of smoky quartz are known that do not carry gold and some others carry on the average too little gold to be mined profitably.

Bodies of white, sugary quartz (the third type) are present at the same localities with the smoky quartz and in a few deposits both types are present in the same quartz body. Crystals of calcite, ankerite and siderite are abundant in some of the white quartz, also albite in twinned crystals. The gold lies between quartz grains near nests of carbonates.

The gold is erratically distributed throughout the white quartz and for this reason certain samples cut from the bodies of white, even-granular quartz assay high, whereas others do not show a trace of gold and the average for the whole mass may be disappointingly low.

Bodies of the fourth or white pegmatitic variety of quartz are widespread, although only a few masses of this type are present at any one locality. This type of quartz is usually barren of sulphides or other minerals excepting feldspar and some mica. Free gold has been found in quartz of this type; however, the deposits usually do not assay even a trace of gold.

Quartz is invariably present where gold values are secured, and it typically forms the bulk of the deposits. Commonly the country rock adjacent to the quartz is silicified or partly replaced and contains the same ore minerals as the quartz. Ankerite and other carbonates are abundant in the quartz and altered rock in some deposits, but lacking, or in small amounts, in others.

Pyrite is present in all deposits, but varies greatly in relative quantity from a barely perceptible trace to a heavy sulphide ore. Chalcopyrite is also present in nearly all deposits, traces in some and conspicuous in others. Frequently, the highest gold assays come from ores in which chalcopyrite is a prominent sulphide. Gold is practically the sole economic mineral of the district. Tellurides occur, but precious metal tellurides are not anywhere conspicuous. Pyrrhotite is rare and entirely absent from many deposits. Arsenopyrite is not a common mineral and is nowhere abundant, except in occurrences at Wallace Lake and southeast of Stormy Lake. Small amounts of sphalerite, galena, and molybdenite occur in some deposits. Tetrahedrite has been found in one locality. Feldspar, white and green micas, and tourmaline are also found. On the whole the latter minerals are not abundant, but locally any one of them may be a prominent constituent of the ore.

Bodies of carbonate-chlorite schist, and massive, grey, carbonate rock are present along some shear zones. They are extensively developed in the workings of the San Antonio mine.

Some Operations in the Area

The initial impetus to the search for metalliferous deposits in this area was the discovery in 1911 of gold in quartz veins on the shore of Rice Lake between Manigotagan and Wanipigow rivers. Since the first discovery, additional finds have been made in the same region each year and the known gold-bearing area has been enlarged to one of considerable size. Gold-bearing quartz veins in shear zones form the only metalliferous deposits of economic interest so far discovered in the area.

The promising prospecting ground of the Beresford-Rice Lakes area is approximately 60 miles long and varies in width from 1 to 15 miles. The best known portions of the area are:

1. That surrounding Rice, Gold and Clearwater lakes.
2. That enclosed in the Long-Halfway-Beresford Lakes triangle.

Both of these have numerous gold-bearing quartz veins and considerable work, both surface and underground, has been done on a number of the more promising veins. The work, however, was done intermittently and for the most part by interests lacking sufficient capital to carry out adequate exploration. Moreover, except during two or three boom periods, comparatively few prospectors remained continuously in the country.

Occurrences of gold have also been found in Anderson Lake area, and along the Wanipigow River system from the San Antonio mine west to Lake Winnipeg.

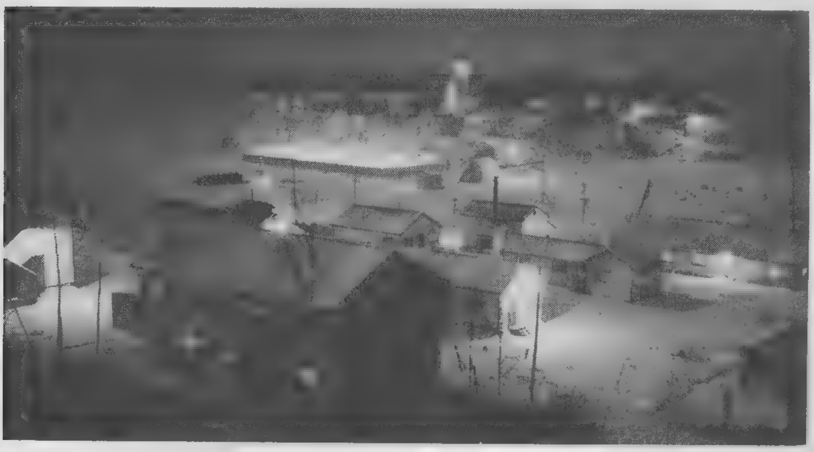
The operations at the Central Manitoba, San Antonio, Gunnar, Jeep, and Ogama-Rockland mines *have established the existence of important orebodies in their respective localities.*

Central Manitoba Mine—At the Central Manitoba mine the ore zone followed a more or less continuous shear striking south 74 to 81 degrees east and dipping from 65 degrees south, at the west end of the property, to 85 degrees north, at the extreme east end of the property. At the west end the quartz bodies were localized along the contact of a mass of diorite or gabbro, which formed the foot-wall, and a band of cherty sediments and andesite pillow lava, which formed the hanging-wall of the deposit. Towards the east, the shear

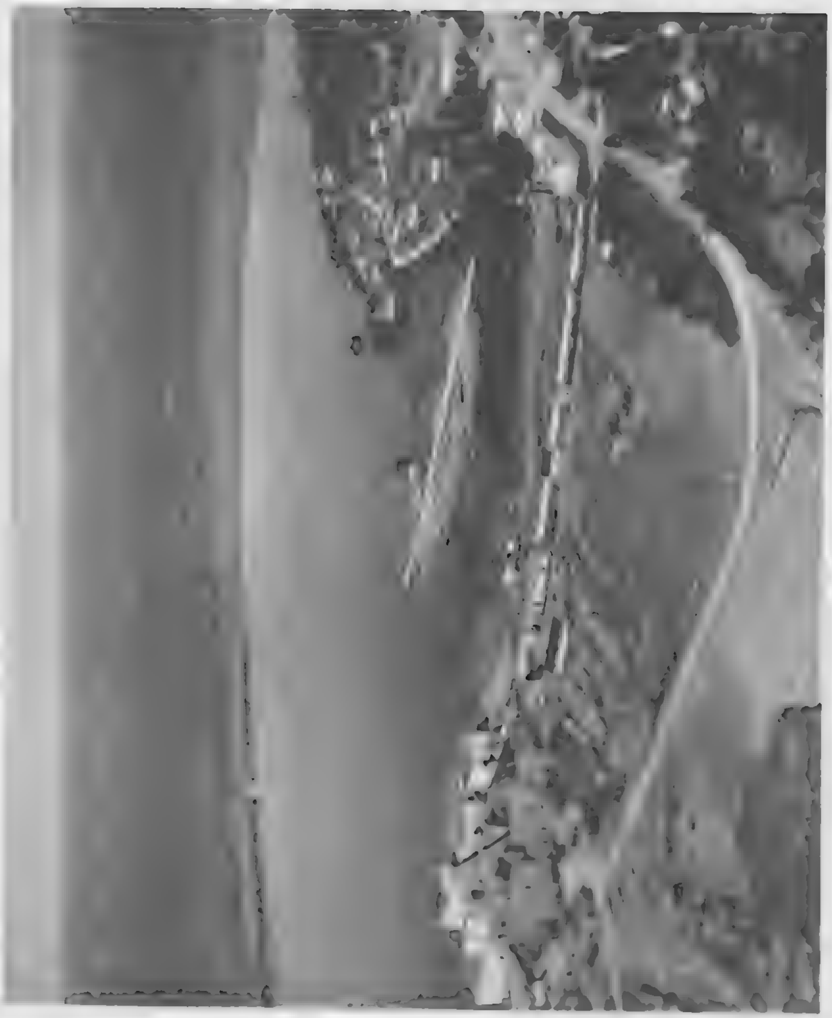
bearing the quartz passed into the diorite. In the workings on the Hope claim at the eastern end of the deposit all of the quartz mined was taken from a shear zone entirely within the diorite.

The ore-shoots of the Central Manitoba mine occurred as lenticular masses of quartz and varied greatly in size. Widths up to 15 feet were found in some of the stopes. The quartz was coarse- to medium-grained bluish to smoky white and had been fractured, allowing the introduction of pyrite and chalcopyrite carrying the gold values. Locally pyrrhotite was abundant. Although free gold was almost entirely absent from the veins, nevertheless a recovery of 25 percent of ore value could be made by amalgamation. Most of the ore was mined above the 375-foot level. During the mine's period of operation from late in 1927 to June, 1937, bullion valued at approximately $4,140,000 was recovered from 437,000 tons of ore milled.

San Antonio Mine—Especially noteworthy is the geological setting of the San Antonio mine. The host rock into which the vein material has been introduced is a dark green rock of variable texture and degree of alteration, probably diabase. It is intrusive into sediments and volcanics of the Rice Lake group. The diabase is of variable width and appears to have its greatest width towards the eastern end of the property, being divided at the west end of Rice Lake by



San Antonio Mine, November 1936.



San Antonio Mine, 1949

a wedge-shaped mass of quartzose sediments. The veins in the mine are most pronounced where the diabase sill reaches its maximum thickness and the veins rapidly die out in passing from the diabase into sediments above and below. The volcanics and sediments along the north shore of Rice Lake are also intruded by an elongate mass of diorite porphyry which so far appears to have no genetic relationship to the orebodies.

The ore is of simple character, consisting essentially of quartz and pyrite. The gold is free but is characteristically associated with pyrite. Chalcopyrite and sphalerite have been noted in the ore but are of rare occurrence. Galena also is found but no arsenical minerals of any consequence have been noted. Tellurides identified as sylvanite are present in some of the newer ores.

The veins are of two types—longitudinal and cross veins. There seems to be no appreciable difference in the grade of the two vein types. It is belived that the cross veins act as feeders for the longitudinal veins, so that structurally they are probably related. There are a number of types of wall-rock alteration which varies from place to place.

The mine made its start on a cross vein, No. 16, which has been a consistent producer ever since milling started in 1932. The later discoveries of longitudinal veins, such as the 26 and 38, have been the greatest producers of the mine. In the deeper developments the No. 50 longitudinal vein has been the main producer of the 16th level where it has a length of 500 feet. The vein has been proven to extend upwards to the 12th level and has been developed at the 17th level at 2,550 feet, the first level off the No. 4 winze. A winze is located northeast of the main shaft and has been sunk to 4,117 feet with the bottom level at 3,864 feet. Widths of 24 feet have been encountered with values in gold of 0.32 ounce per ton. New cross veins have been picked up on the 17th level to the northeast of the main crosscut.

Ore of mine average grade and width has been found on all levels on which recent work has been done. A good part of the San Antonio ore structure rakes into the adjoining Fourty-Four ground. Forty-Four Mines Limited is controlled by San Antonio Gold Mines Limited, and diamond-

drilling from a line drive into this property has intersected both cross and longitudinal veins of ore grade.

A net profit of $461,150.79 on recovery of $1,876,066 from 177,900 tons of ore milled, is shown by San Antonio Gold Mines in its annual report for 1950. This report also discloses a recovery of $10.44 per ton. Ore reserves at this year-end were computed at 710,000 tons. Milling is now being carried on at, or near, the capacity rate of 550 tons a day.

In the area surrounding the San Antonio deposit, it is significant to note that the concentration of gold values frequently occurs where bodies of quartz lie in or abut against masses of basic rock or volcanics. Although emphasis has been placed on structural control it is also possible that diabase was more favourable to alteration by the gold-bearing solutions than were the other rocks.

The Jeep Gold Mine Limited—This mine, controlled and managed by San Antonio Gold Mines Limited, began operation in 1948. It was closed down in 1950 following extraction of the ore from the No. 1 vein and because the grade in the parallel vein did not stand up to the high cost of the operation. During 1949 the mine produced 25 tons of ore a day which was conveyed by truck to the San Antonio mill, 10 miles distant to the west. The grade of ore was about $31.50 a ton.

Ogama-Rockland Gold Mines Limited—The Ogama-Rockland mine situated at Long Lake began production in 1942 when $45,109 was recovered from 4,121 tons shipped to the Gunnar mill. No production was recorded from 1942 to 1948. A 150-ton mill was installed in 1948 and mine production was maintained throughout 1949 with exception of a temporary shutdown in November. The main shaft was deepened to the 1,000-foot level early in 1950 and development carried out on diamond-drilling intersections at both the 875- and 1,000-foot levels. Results from this work proved disappointing. Diamond-drilling below the bottom level (1,000-foot) yielded some encouragement. However, rising costs and the necessity for further financing resulted in the decision to close the mine after extraction of existing ore reserves. Final mill clean-up was completed at the end of June, 1951.

Production from the mine to the end of 1950 totalled \$1,396,435 from 125,583 tons for a mean recovery of \$11.12 per ton.

Gunnar Mine—At the Gunnar mine narrow, well-mineralized quartz veins followed shear zones developed along the flow-tops of lavas. The veins appeared to be genetically related to the Tinney Lake granodiorite mass, but dipped away from the intrusive contact at the surface into the volcanic rocks. The youngest dyke rock on the property is a biotite lamprophyre. The vein material consisted of quartz, carbonate, pyrite, chalcopyrite, dark sphalerite, and gold. Most of the gold was "free-milling." From May, 1936, to May, 1942, when the Gunnar mine ceased operations, bullion valued at \$3,719,942 was recovered from 298,829 tons of ore milled.

The Oro Grande shear west of Beresford Lake is in the east side of a body of medium-grained basaltic rock between beds of andesitic lava and tuff.

The Diana (Gem Lake) deposit is along a wide, schistose zone developed within andesitic lava adjacent to a body of medium-grained basaltic rock.

The shear zones in the granitic intrusives, as at the Eldorado property and the Luleo property west of Beaver Lake, are within central parts of tongue-shaped bodies of intrusive rock, or else close to the contact of these bodies with the lavas and sediments.

It thus appears that areas underlain by rocks of varying competency under deformation are favourable to prospect, and, perhaps, the variable texture and composition of the volcanic and sedimentary rocks of the Rice Lake group explain the localization of the majority of the quartz bodies of the district to areas of these rocks.

The Beresford-Rice Lakes area during the last 30 years has been the scene of much prospecting activity that reacted in an erratic and intermittent manner to the ability of the prospector to raise money for his endeavors. Many promising showings have attracted attention for a couple of years only to be lost sight of through lack of funds or failure on the part of the prospector to trench into deep overburden or across the entire width of shear zones. Systematic and careful sampling has been lacking on many deposits which

might stand up better under careful work. Fractioning of channel samples across many shear zones in some cases gives surprising results and may serve to give the clue to the limits and extent of an ore zone that would otherwise be missed if the entire sample were considered.

One noteworthy example of what may be done by prospecting old surface showings may be cited in the property of the Gunnar gold mine. This mine had its orebody adjacent to or along old showings which, had they been prospected more thoroughly, would have yielded a mine at least five years sooner.

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PONASK-STEVENSON LAKES AREA

Ponask and Stevenson Lakes are situated due east of the north end of Lake Winnipeg, about midway between Norway House and Island Lake. Both are on the water route to Island Lake. Ponask Lake, the most westerly of the two, is reached by canoe and outboard motor via Gunisao and McLaughlin Rivers and Ponask Creek, in from two to three days' travel. Fourteen short portages are made en route. The west end of Stevenson Lake is only 6 miles east of Ponask Lake, but the canoe route connecting the two lakes is about 24 miles long and leads from the south shore of Ponask Lake over the height of land via two portages each about ¼ mile in length, followed by two 1-mile portages, and then via Lonenest and Pelican Lakes and their connecting streams into the south side of Stevenson Lake.

General Geology

A long narrow schist belt of altered Precambrian sediments and volcanics, having an average width of from one-half to three-quarters of a mile, extends along the southern shores of both lakes for a distance of at least 55 miles. *The belt may extend through to Island Lake, where similar rocks were mapped as the Hayes River group.* If so, it has a length of some 80 miles west of Island Lake.

The geological succession consists of sediments, volcanics and granite. The sediments are composed of conglomerate, quartzite, greywacke, and slate. The greater part of the sediments are greywackes which are difficult to distinguish

from the volcanics. Drag-folded slate with excellently developed cleavage is found toward the east end of Stevenson Lake.

Intermediate to basic volcanics outcrop along the entire south shore of Ponask Lake, the sediments being mainly in the lake. On Stevenson Lake the volcanics occur in smaller proportions. Throughout the belt they usually lie immediately south of the sediments and seem to occur in more or less lenticular masses, whereas the sediments maintain fairly regular thicknesses.

Granites lie to the north and south and are intrusive into the older rocks. Pegmatite dykes occur chiefly on the north shore of Ponask Lake.

Mineral Occurrences

A few lenticular quartz veins are reported in the volcanic-sedimentary complex. Some carry pyrite and chalcopyrite.

Greer states: "*A remarkable feature of the granite-volanics contacts is the abundance of small quartz veins intrusive along the strike of the volcanics. . . .*"

They were especially noted southeast of the second portage below Ponask Lake and south of the east end of Stevenson Lake.

The area received little attention from prospectors until late in 1933, when a discovery was made near the east end of Stevenson Lake. A small staking rush resulted and about one hundred claims were staked at Stevenson and Willow Lakes.

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ISLAND LAKE AREA

Island Lake lies between 53 degrees 30 minutes, and 54 degrees north latitude, and 94 degrees and 95 degrees west longitude. Its eastern extremity, Sagawitchewan Bay, is crossed by the Manitoba-Ontario boundary line and its west end lies due east of the north end of Lake Winnipeg, a distance of about 120 miles. It is about 300 miles by air

line north-northeast of the city of Winnipeg. Since 1931 travel to and from the Island Lake area has been mostly by aeroplane.

Island Lake is one of the larger lakes comprising the headwaters of Hayes River which drains into Hudson Bay. It derives its name from the vast number of islands, 3,475 of which have been mapped and examined geologically.

During summer a water route from Norway House via McLaughlin River, Ponask Creek and Ponask and Stevenson Lakes is used by parties travelling by canoe. The distance is estimated at 160 miles with thirty-four portages. Four of these over the height of land between Ponask and Lonenest Lakes are 1,400, 1,600, 6,200, and 6,500 feet long, respectively; and two over a second height of land into Collins Bay, Island Lake, are 1,650 and 4,300 feet long. Ponask Creek is crooked and narrow and difficult to navigate in low water. The trip usually takes from seven to ten days, depending upon load carried and weather conditions.

Island Lake was first surveyed and explored by A. S. Cochrane, of the Geological Survey of Canada, in 1878. In 1925 the Topographical Surveys Branch made a control traverse of the lake and in conjunction with the Royal Canadian Air Force photographed the area. In 1927, J. F. Wright, then of the Geological Survey of Canada, made a detailed study of the geology.

Following the publication of his report a few prospectors entered the area during the seasons of 1928 and 1929. Claims were staked at four different points on the lake:

1. On some islands about 3 miles south of the Hudson's Bay post.
2. On Confederation Island.
3. On islands lying to the east towards Sagawitchewan Bay.
4. On Wapus Bay.

Interest in the area then waned for several years and most of the claims were allowed to lapse.

During the summer of 1944 there was a revival of interest in gold prospecting and a number of claims were staked throughout the area.

General Geology

The Island Lake area is underlain by rocks of Precambrian age, the oldest of which is a complex of lavas and sediments classified as the Hayes River group. *This constitutes the favourable prospecting ground about Island Lake and is 70 miles long and varies in width from 1½ to 14 miles.*

The group is dominantly of volcanic rocks, the sediments, though widespread, being localized to certain horizons alternating with lava flows. Black, medium-grained basalt, black, fine-grained andesite, and grey flows of dacite are abundant. Rhyolite is only locally present as thin flows with dacite and andesite. The basalt weathers greyish or brownish and some parts of flows are porphyritic with areas containing crystals of feldspar up to 1½ inches long. Pillows are well developed in many flows. All types of lavas are locally altered to schists, containing carbonate, chloritic, and sericitic minerals.

The sediments alternating with the lavas include tuffs, chert, iron formation, cherty quartzite, greywacke, and thin beds of arkosic and conglomeratic materials.

A younger body of sediments, designated the Island Lake series, occupies a syncline within the Hayes River formations and outcrops on the islands within the east-central part of Island Lake. The series has an average dip of about 40 degrees and rests uncomformably on the Hayes River rocks which dip at angles of 70 degrees or over.

The Hayes River group is cut by dykes and sills of fine- to medium-grained diorite and gabbro, by granite and granite-gneiss younger than this diorite and gabbro, by small dykes and lenticular bodies of granite porphyry, and by dykes of massive diabase, the youngest rocks recognized in the area.

A belt of volcanic and sedimentary formations approximately 30 miles long by 4 miles wide lies in the basins of Bigstone, Knight, and Clam Lakes, a distance of some 15 miles west of the south end of Island Lake. The volcanic rocks of the area have been tentatively identified with the Hayes River group in the Island Lake area to the east.

Gold occurs in quartz veins within the area. Such veins are most likely to occur in zones of more intense folding and

in the vicinity of small bosses of granitic rocks or where there are marked projections from the main granite mass into the lavas and sediments. *Shear zones in which sulphides and carbonates are prominently developed should also be investigated.*

In the area between Knight and Wass Lakes gold has been panned at several places.

Mineral Occurrences

Small lenticular quartz veins occur at many localities within shear zones in the volcanic members of the Hayes River group. The gold-bearing quartz is medium-grained and white to dark grey in colour, and it occurs as veins, lenses, and stringers. The gold is distributed throughout the quartz in small particles. Sometimes it occurs as films in cracks. Some deposits contain, in addition, pyrite, chalcopyrite, sphalerite, arsenopyrite, and galena. Most quartz containing galena is gold-bearing, and the most consistent average assays are from schist bodies that carry dark quartz in stringers and veins, the quartz forming over half the area sampled.

Wright says: "The area that may contain mineral deposits is a large one," and in later notes draws particular attention to "the area around the end of the granite batholith extending east from Loonfoot island" as a favourable one to prospect, "as some of the lava for several miles west of the granite is altered to schist, which is sparingly mineralized with quartz and sulphides, and at a few localities the lava is almost completely changed to large bodies of carbonates"; and

"Another apparently lenticular-outlined body of granite, about 16 miles long, lies along the north shore of Island lake, from Pickerel narrows to Cochrane bay, and the lavas and sediments adjoining this mass should be examined carefully. Narrow dykes of quartz porphyry cut the lavas at points along the south margin of this granite body."

Early Developments

In 1931 two groups of claims were staked on islands lying between Confederation Island and Sagawitchewan Bay. Samples brought to Winnipeg from the westerly group created wide interest because of the uniformly high assay

returns in gold. Ventures, Limited soon acquired the property and a staking rush followed in the winter of 1931-1932.

The original find was diamond-drilled during 1932. A mining plant and complete equipment for a 50-ton mill were then freighted to the property by winter road early in 1933. The mill came into production in April, 1934, but closed the following spring when the company reported that no ore had been found below the first level.

During 1932 finds were reported in Sagawitchewan Bay at the east end of Island Lake and at Bigstone and Clam Lakes to the west and southwest of Island Lake.

During a part of 1937 mining development operations were conducted by Ministik Lake Gold Mines Limited on a gold-bearing quartz vein situated on High Rock Island, southeast of Confederation Island.

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MAX AND ASWAPISWANAN LAKES AREA

Aswapiswanan Lake is on the canoe route to Gods Lake, and Max Lake adjoins Logan Lake which is crossed by canoe parties travelling to both the Gods and Oxford Lake areas. In 1926 some prospecting was done in these belts and they were looked over again by parties travelling from Gods Lake during 1932 and 1933, but no discoveries were reported.

Narrow belts of Hayes River lavas extend westward for considerable distances from Max and Aswapiswanan lakes.

South of Max Lake they are separated by two miles of granite. The lavas include massive and schistose basalt, andesite, and trachyte. Some schist zones contain veins and stringers of quartz. The quartz and adjoining schist carry sulphides. Enclosed in the lavas are a few horizons of bedded and schisted sediments, some of which are probably partly recrystallized tuffs. Dykes of granite and granite porphyry and narrow dykes of diabase are also present in the lavas.

REFERENCE

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MUNRO LAKE AREA

The Munro Lake area lies due north of Aswapiswanan Lake from which it is easily reached by canoe down Mink River about 3 miles and then up a branch stream 1½ miles to Colen Lake. From a bay on the north shore of Colen Lake a short stream leads into Munro Lake.

The area is not known to have been prospected until 1933, when it was visited by several prospectors travelling to or from Gods Lake.

A belt of favourable prospecting ground about 4 miles wide extends for at least 12 miles eastward through Munro Lake from the north shore of Colen Lake.

The rocks are chiefly basalt, andesite, greywacke, and tuff of the Hayes River group. The sediments are more abundant within the lavas than in some of the neighbouring greenstone areas, and at some horizons they are at least 300 feet thick. Wide belts of schist derived from lava and tuff alternate with massive lava.

The area is cut by many long, narrow dykes of granite porphyry which follow closely the dip and strike of the Hayes River strata. Stringers and veinlets of quartz occur in the jointed granite porphyry dykes and adjoining schist zones. Schist zones carrying quartz and sulphides also occur in the lavas some distance from the porphyry dykes.

REFERENCE

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GODS LAKE AREA

Gods Lake lies due north of Island Lake, the distance between their closest points being less than 30 miles. It is about 100 miles southeast of Ilford, Mile 286, on the Hudson Bay railway, and 140 miles northeast of Norway House.

During the period of operations of the Gods Lake mine, planes served the area from Ilford during the winter and Norway House during the summer. A winter road from Ilford was used for freighting supplies and equipment.

The canoe route which has been much travelled since 1932 starts from Norway House and follows Nelson, Echimamish, and Hayes rivers to Robinson and Logan lakes. From the south shore of Logan Lake the route follows a chain of small lakes to Aswapiswanan Lake, and thence by way of Mink River, Touchwood Lake, and a short stream to a bay in the Indian reserve near the west end of Gods Lake. There is a 60-chain portage between Robinson and Logan lakes and thirteen portages between Logan and Gods lakes, one of which is 90 chains long. The remainder range between 8 chains and 40 chains in length. The trip requires about six days' steady travelling.

General Geology

The main prospecting area, some 35 miles long and reaching a width of 15 miles at one point, comprises the larger islands in the lake and large stretches of the mainland east of Gods Narrows.

The abundant rocks of the area are black and brown, weathering to grey, basaltic and andesitic lavas of the Hayes River group. A few beds of tuff occur between the basalt flows.

A younger series of sediments, classified as the Oxford group, overlie the Hayes River rocks. They consist of a long band of conglomerate averaging about a half mile across, arkose, and beds of fine-grained quartzose and clayey sediments. Steeply dipping, they lie west of the lavas between these rocks and the granite and appear to be on the south limb of a broad anticline whose crest is occupied by the Hayes River group.

Members of both the Hayes River and the Oxford groups are cut by dykes and bosses of granite, granite porphyry, and gabbro.

Bands of green chloritic schist occur between the ridges of massive lava, and belts of mica ribbon schist, parts of which contain lenses and stringers of quartz and granite, occur at some localities in the Oxford sediments.

The Hayes River lavas on Elk Island and the group of islands to the west and northwest contain many dykes of granite and granite porphyry. Gabbro is also abundant as dykes and lenticular masses particularly in the Oxford series.

Many shear zones in the lavas are quartz-bearing and may also contain pyrite, chalcopyrite, galena, and arsenopyrite. *These mineralized belts of quartz and schist in the neighbourhood of granite porphyry dykes are considered worthy of careful prospecting for gold. Discoveries in the area have shown that the tuff beds must be examined carefully, as the main occurrence so far discovered is in a fractured tuff bed carrying numerous quartz stringers.* The tuff bed lies between two basalt flows and is very close to a gabbro sill which intrudes the lavas.

Drift deposits are widespread in the vicinity of Gods Lake. Much of the country to the east and southeast of the lake is virtually unexplored. The lake itself covers a considerable area and prospecting has been confined principally to Elk Island.

With the development of the Sachigo River Gold Mines Limited in Ontario, 110 miles east of Gods Lake, there was a display of interest in the Stull Lake area which lies approximately midway between these two points. In this area rocks of the Hayes River and Oxford groups occur chiefly as four belts trending east and west within large masses of granitic rocks. The lavas and sediments are cut by dykes of granite, pegmatite, aplite, quartz and feldspar porphyries, and diabase. Mineralization consists of pyrite and arsenopyrite in quartz lenses in sheared and fractured zones; disseminated pyrite and pyrrhotite in shear zones and in silicified sediments; and disseminated pyrite, pyrrhotite, and arsenopyrite in porphyry dykes.

Mineral Occurrences

Three different types of gold occurrences have been noted:

1. A fractured zone in a quartz porphyry dyke. The fractures are filled with blue quartz stringers which carry very fine pyrite and arsenopyrite and some free gold. The porphyry is mineralized with pyrite and pyrrhotite.

2. Zones of silicified andesite schist well mineralized with fine pyrite and pyrrhotite.

3. Tuff beds between basalt flows.

Early Developments

Very little attention was paid to the Gods Lake area by prospectors prior to 1932. A few parties had visited the area at different times and some attention was paid to it during 1928 and 1929 by the Northern Aerial Minerals Exploration Company, Limited and others. In 1931 the area was explored geologically by J. F. Wright, then of the Geological Survey of Canada, who states in the concluding sentence of his report: "This area would appear worthy of much more detailed prospecting than hitherto has been undertaken."

In 1932 R. J. Jowsey with a prospecting party entered the area and soon made a discovery of gold on a small island north of the west tip of Elk Island. Other prospecting parties were quickly on the ground, and during the remainder of 1932 and early in 1933 many other discoveries were made, mainly on Elk Island.

Many claims were staked during the period and early in 1933 several companies were organized to acquire claims in the area. The first company to undertake active development was Gods Lake Gold Mines Limited, organized by R. J. Jowsey. This company had the original find in the area and in addition several groups of claims extending eastward along Elk Island.

Subsequent developments proved sufficient ore to warrant construction of a 200-ton mill. A power plant of 1,900 horsepower capacity was completed at Kanuchuan Rapids some 40 miles southwest of Gods Lake settlement. Milling

began within three years of the initial discovery at Gods Lake. During the life of the mine from September, 1935 to September, 1943 bullion valued at $5,926,111 was produced from approximately 541,140 tons of ore.

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BEAVERHILL LAKE AREA

The Beaverhill Lake area lies immediately south of the west end of Gods Lake to which it is connected by 3 miles of stream, including the Kanuchuan Rapids.

Hayes River lavas and Oxford sediments outcrop east and northeast of the lake over an area at least 25 miles long and 4 miles wide at one point. The lavas include andesite and basalt. Some flows showing pillow structure are interlayered with beds of tuff and greywacke with slaty cleavage. Wide belts of lava and associated tuff are altered to chlorite and carbonate schist. Some contain stringers of quartz. Granite porphyry, aplite and pegmatite dykes, although not abundant cut the lavas in some localities.

It is not known that the area has been prospected to any extent but in view of the finds in the neighbouring Gods Lake area, the lavas and sediments of the Beaverhill Lake area should be examined carefully.

REFERENCE

Wright, J. F.:
"Oxford House Area, Manitoba;" Geol. Surv., Canada, Sum. Rept. 1931, pt. C, p. 23.

OXFORD-KNEE LAKES AREA

The Oxford-Knee Lakes area lies between latitude 54 and 55 degrees and longitude 94 and 96 degrees. Oxford Lake is about 100 miles, and Knee Lake 125 miles, northeast of Norway House.

The area has an east and west length through Oxford and Knee Lakes of at least 65 miles and may extend southeast another 18 miles from Fishing Eagle Lake to the outlet of Gods Lake. The greatest known width is 13 miles, although its margin south of the west end of Knee Lake has not been explored because of lack of canoe routes.

The flying distance to both Oxford and Knee Lakes from Ilford, Mile 286 Hudson Bay railway, is approximately 80 miles. The winter road from Ilford to Gods Lake crosses Knee Lake and Whitemud Lake just north of the east end of Oxford Lake from which a road leads to Oxford Lake via Peemow Lake.

Two canoe routes reach the area. The most travelled route leads from Norway House down Nelson River to the junction with Echimamish River. En route a portage is made at Sea River falls. Echimamish River is ascended 35½ miles to the divide where the Painted Stone portage, 100 feet long, leads to Hayes River, which is then followed downstream through Robinson, Logan, Opiminigoka, and Windy lakes to Oxford Lake. Below Robinson Lake, a portage 60 chains long is crossed by a pole tram-line. The remaining portages are short. The distance by canoe between Norway House and Oxford Lake is approximately 150 miles, with eight portages, and the trip takes from four to ten days, depending upon the amount of freight carried and weather conditions. Knee Lake is reached from the east end of Oxford Lake by Hayes River in a stretch of 11 miles which includes several portages.

A second canoe route is sometimes used from Mile 214, Hudson Bay railway, up Nelson River to Clearwater River and thence up this river to Clearwater Lake. The route crosses Clearwater Lake and follows east and southeast across Bear Head, High Hill, Stony, and Utik lakes, including stretches of streams and several short portages. A portage, three-quarters of a mile long, is then made to Big-

stone Lake, and Bigstone River is ascended to Bear Lake. Another portage, three-quarters of a mile long, leads into a small lake from which a third portage, 1 mile long, is made into Powstick Lake, which in turn is connected by stream with Semple Lake and Semple River to Oxford Lake.

This second route is about 75 miles long. It was first explored in 1923 by R. C. McDonald, Topographical Survey of Canada, who found that it could be easily travelled in three days with light loads. As it makes a direct connection with Hudson Bay railway it may be more favoured in the future if much travel develops to the Oxford-Knee Lakes area.

In 1936 some 200 claims were staked along Echimamish River and exploratory development work, including diamond-drilling, was conducted on several gold occurrences.

General Geology

The first information on the geology of the area was obtained by Robert Bell, who explored Hayes River for the Geological Survey of Canada in 1878 and 1879. In 1919 E. L. Bruce mapped and made a detailed study of the geology of Knee Lake and in 1925 J. F. Wright made a geological survey of Oxford Lake.

The Oxford-Knee Lakes area is underlain by one of the largest belts of Precambrian lavas and sediments in the Province, with the distribution of the Hayes River and Oxford strata being the greatest of any area in northeastern Manitoba.

Along the first route into the Oxford-Knee Lakes area a small belt of volcanic and sedimentary rocks of the Hayes River group is encountered along the valley of Echimamish River 12 miles upstream from where it enters Nelson River. The belt is 20 miles long and ranges in width from $1\frac{1}{2}$ to 4 miles. Two types of deposits have been recognized: gold-bearing quartz veins, and sulphide replacements in felsitized zones. Both types generally occur in the vicinity of dykes and small bodies of intrusive rocks. The principal occurrences are located in the altered lavas along the northern part of the belt.

In the Oxford-Knee Lakes area proper, rocks of the Hayes River group lie along the north margin of the belt and

also along the south margin from near the west end of Oxford Lake to four miles east of the inlet of Hayes River. From the west end extending through the central part of the lake, Oxford sediments lie between the lavas. They continue eastward but are bordered on the south by granite. Small dykes of gabbro cut the Hayes River lavas near the west end of Oxford Lake and a few small dykes of quartz and feldspar porphyry cut the greenstone along the north shore of Knee Lake. Small bodies of intrusive rock, however, are not known to be abundant in the Hayes River and Oxford groups of the area, except at a few localities. The lavas and sediments adjoining the granite are only locally recrystallized or otherwise altered by the effects of the granite magma.

In summarizing his investigations Bruce states: "The character and sequence of the rocks of Knee Lake district are comparable with those of the rocks occurring in districts in which payable ore deposits have been found."

Much of the area is covered by a thick mantle of Pleistocene deposits and rock outcrops occupy a very small percentage of the whole area. Some particular features of the Knee Lake area are given in the following paragraph:

"*Assuming that mineral deposits are associated with igneous intrusions, the rocks bordering the small intrusions of granite southeast of Cinder Lake and east of the second narrows of Knee Lake are the most likely localities for concentration of metallic minerals. Any of the rocks prior to the granite may possibly contain veins, but the brittle, massive rocks such as the lavas are more likely to contain large and continuous veins than are the soft and heterogeneous sedimentary beds. The quartz veins that have been found to be auriferous occur in fractured quartz-porphyry dykes.*"

Mineral Occurrences

Knee Lake was evidently the first part of the Oxford-Knee Lakes area to receive attention from prospectors. Gold is reported to have been first discovered there in 1918. When Bruce mapped the Knee Lake area in 1919, claims had been staked at two places on the lake; on a point in Painkiller Bay and on the east end of Magennis Island.

Encouraged by surface showings, Knee Lake Gold Mines sank a two-compartment shaft to a depth of 325 feet on the south shore of Knee Lake in 1935. Development disclosed some high grade shoots which were short, narrow and erratic, making it difficult to correlate diamond-drill and drift values. Work was discontinued in 1936.

At Oxford Lake some early development work was undertaken on deposits of iron carbonate at Hyers Island. However, the main interest in the lake as a prospecting area dates from 1922 when work was commenced on a mineralized shear zone in greywacke located on the south shore of the lake opposite Cargill (Carghill) Island. The occurrence was later staked as the Lynx group of claims. It comprises a belt of chlorite and sericite schist cut by narrow veinlets and small lenses of quartz and massive sulphides, including pyrite, chalcopyrite, sphalerite, and galena. The quartz is quite abundant in places, and contains some gold. The schist is thought to be derived from tuff or greywacke; it adjoins andesite on the south and the area of Hayes River rocks is believed to be only a narrow tongue within the large body of granite to the south.

In 1924 claims were staked on a wide belt of schist outcropping at the east end of Hyers Island. This body of chlorite, talc and sericite schist lies in lavas of the Hayes River group and is mineralized with iron, copper, zinc, lead, and antimony sulphides and gold-bearing quartz.

In the autumn of 1928 twenty-two holes were diamond-drilled on a copper-gold deposit at the northeast corner of Hyers Island. This deposit lies along the south margin of the schist belt where quartz and chalcopyrite are more abundant than elsewhere.

Large bodies of iron carbonates occur along the schist belt on the north side of Hyers Island. Wright states that one of these is at least 3,000 feet long and 50 feet wide.

In concluding the notes on the Oxford-Knee Lakes area, it may be pointed out that in addition to the mineral occurences already mentioned:

"The Hayes River lavas on the north shore of Oxford Lake near the east end of Cargill channel are cut by narrow quartz veins, and some of these contain free gold. All the gold-bearing

quartz is at or near the water-level on small islands or points. Some quartz float carries abundant free gold."

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BIGSTONE AND FOX RIVERS AREA

The Bigstone and Fox Rivers area includes the country traversed by Bigstone and Fox rivers from Bigstone Lake to Hayes River. It has a length of about 100 miles in a north-easterly direction from Bigstone Lake which lies about 30 miles north of Oxford Lake. The area is flat-lying and deeply covered with drift except along the waterways. It can be reached by canoe from Oxford Lake or Mile 214, Hudson Bay railway, by following the second canoe route to the Oxford-Knee Lakes area (see Oxford-Knee Lakes area).

Bigstone Lake which lies 30 miles north of Oxford Lake should not be confused with a lake of the same name which lies 15 miles west of the south end of Island Lake.

Merritt lists three main bands of volcanic rocks and two bands of sedimentary rocks in the area traversed. Volcanics and sediments outcrop at Bigstone Lake. A second band of volcanics crosses Bigstone River 15 miles below the lake and a third band follows Fox River for a considerable distance.

A serpentine rock extends for a mile along the shore of Fox River about six miles below Bigstone River. The second band of sediments outcrops along the lower stretches of Fox River for a distance of 25 miles.

Pegmatite dykes occur on Bigstone Lake and diabase cuts the lavas on Bigstone Lake and the granite on the river above the lake.

REFERENCE

Merritt, C. A.:
"Bigstone and Fox Rivers Area, Northern Manitoba;" Geol. Surv. Canada, Sum. Rept., 1925, pt. B, pp. 27-30.

CROSS-PIPESTONE LAKES AREA

The Cross-Pipestone Lakes area lies about 60 miles north of Lake Winnipeg. The area has for its northern and southern boundaries latitudes 54 degrees 51 minutes, and 54 degrees 24 minutes, respectively; in an east and west direction it includes ranges 1 to 5 west, and range 1 east of the Principal meridian.

Cross Lake may be reached from Winnipeg either by way of Lake Winnipeg and Nelson River or by way of The Pas and Hudson Bay railway. The former is the summer route. The journey from Norway House to Cross Lake, a distance of about 60 miles, is made by canoe in one or two days. On approaching Pipestone Lake, the narrow, westerly channel of Nelson River is followed.

All the consolidated rocks of the Cross-Pipestone Lakes area are Precambrian in age. Most of the region is underlain by granite and granite-gneiss but a narrow belt of older rocks extends along either side of Pipestone Lake and another belt is found on some of the islands of Cross Lake. The strike of the rocks of the Pipestone Lake area is northwest, whereas in the Cross Lake area it is northeast. Deep erosion has uncovered the granite until only mere remnants of the older rocks, into which it was intruded, are left today.

Greenstone lavas outcrop intermittently all the way from Oxford to Walker Lakes, just south of Cross Lake, along Carrot River.

In 1929 considerable surface work was done on a group of claims situated on the small islands about four miles northeast of the Hudson's Bay post in Cross Lake.

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HERB LAKE AREA

The Herb Lake area surrounds Herb (Wekusko) Lake, which is situated 12 miles north of Mile 81, Hudson Bay railway. It is usually understood to include several small lakes, such as Squall, Herblet, Snow, and Tramping Lakes, along which claims have been staked at one time or another during the past thirty years.

The area is easily accessible and is reached from The Pas over the line of the Hudson Bay railway to Mile 81, and then north 12 miles over a motor road to the south end of Herb Lake. During the summer months a launch service is maintained between the south end of Herb Lake and the settlement on the east side of the lake, a further 12 miles to the north. Horses and sleighs are used during the winter between Herb Lake and the railway. In 1946, a road was constructed between Mile 81 on the railway and Snow Lake (Nor-Acme mine).

General Geology

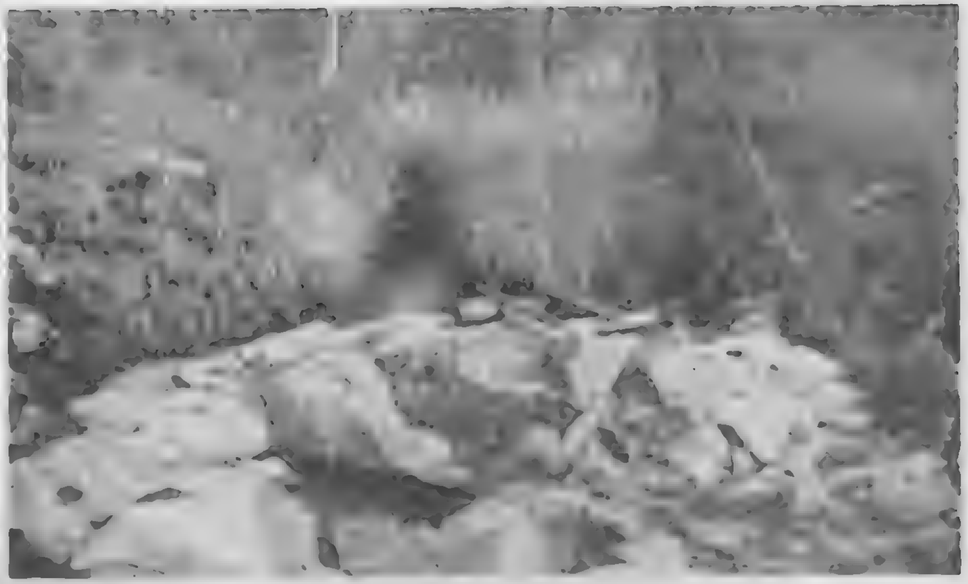
The area was first noted as prospecting territory by Tyrrell during his explorations in 1896. In his report he described the Precambrian lavas and sediments in some detail and mentioned the occurrence of quartz veins. Subsequently the area was examined in varying detail by Alcock, Bruce, Stockwell, and Armstrong. The most recent and detailed work is that of Harrison (1944-46) from whose memoir the following is mainly drawn.

The rocks of the area, excepting a belt of Ordovician dolomite towards the south, are all Precambrian. The older rocks of the area are mainly basic lavas, pyroclastics, breccias, and tuffs, with some diorite and gabbro, and their metamorphic equivalents. These rocks are correlated with the Amisk volcanics of the Flin Flon district. Overlying the older rocks and possibly separated from them by a

period of granitic intrusion and folding, is the Snow group, which, with the Amisk, is equivalent to the Wekusko group as named by Alcock. The Snow group is composed of gneisses and schists derived from argillite and greywacke, acid volcanics, basic flows, and pyroclastics, and minor basic intrusions, as well as sandy sediments. This group bears some resemblance to the Missi sediments of the Flin Flon area, but there are considerable differences in lithology and structure, so that no good correlation is yet possible. The Amisk, at least, is intruded by a characteristic "quartz-eye" granite, and by quartz-feldspar porphyry and rhyolite, whose relations to the Snow group are not known. A further group of basic intrusives, ranging from peridotite, pyroxenite, and gabbro through quartz diorite, was succeeded by more siliceous material. The youngest major group ranges from quartz diorite to massive biotite granite. The earlier rocks have been metamorphosed, with the most intense changes in the northern part of the area and around the margins of the intrusives. Though several major folds and domes have been recognized, the folding, in detail, is complex. Faults are numerous, are characteristically curved, and probably are of two ages. They have considerable length; for example, the Berry Creek fault has been traced for thirty miles.

Mineral Occurrences

The *Nor-Acme* property of the Howe Sound Exploration Company, Ltd. is located on the crest of an overturned isoclinal fold on the north side of Snow Lake. The wall-rocks are feldspathic sediments with some interbedded acid lavas and basic breccia, all of which are cut by basic intrusives. The two orebodies are at the contact between layers of basic breccia and the sediments, and plunge with the crests of minor anticlinal folds. There has been alteration and bleaching of the rocks adjacent to the ore, with development of tourmaline and epidote, and addition of albite. The orebodies are connected by a small fault, which probably aided in localizing the ore solutions. Gold has not been found in the quartz of the veins, but it is in the silicified wall-rock and in inclusions within the quartz, where carbonate is abundant and appears to have had some effect on the



Outcrop of ore-body showing location of first diamond-drill hole
across Nor-Acme deposit.
1944

Snow Lake mine and townsite, 1950.

deposition of the gold. The metallic minerals associated with the gold are arsenopyrite, pyrrhotite, pyrite, chalcopyrite, and sphalerite. The finer and more abundant the arsenopyrite the higher is the gold content, though not all the gold is in the arsenopyrite. A 2,000-ton mill was put into operation on the property in 1949.

The *Laguna* mine was first developed in 1918, following the discovery of gold in 1914, by M. J. Hackett and R. Woosey, who had prospected the area on the basis of Tyrrell's report of 1900. Herb Lake was, accordingly, the first place where gold was discovered in northern Manitoba. It also yielded the Province's first production of gold from quartz when, in 1917, a carload of ore was shipped from the Moosehorn and Ballast claims to the smelter at Trail, B.C.

Under the name of the *Rex* mine there was sporadic production up to 1923. During 1924 and 1925 a total of 5,555 ounces of gold was produced. Two shallow shafts were sunk during this period. After 1934 the shafts were deepened and considerable drifting was done on seven new levels, under the name of the Laguna mine.

The orebody at the Laguna consisted of a sugary-textured quartz vein that was locally well-mineralized with arsenopyrite, pyrrhotite, and gold, with sparse amounts of chalcopyrite and galena. Most of the gold appeared to be associated with the arsenopyrite mineralization. The vein followed, rather closely, the contact of a lamprophyre dyke that cut an intrusive stock of quartz-porphyry (rhyolite). To the north the vein passed into the foot-wall sediments—arkose and conglomerate. Small fault displacements were noted in the vein, but none of these exceeded 5 or 6 feet, so that there was little difficulty in following the vein.

Production from the Rex and Laguna workings, at the close of operations early in 1940, totalled 59,970 ounces of gold, valued at $2,019,973, and 6,478 ounces of silver, valued at $2,787.

In the same immediate area considerable work was done on the *Bingo* property at intervals from 1919 to 1927. A shaft was sunk to 400 feet and four levels opened. A production of 128 ounces of gold was reported in 1926.

In 1932 about $12,000 in gold was extracted from a quartz lens on the *Ferro* property.

Though the Laguna and the Nor-Acme are the only mines from which there has been a noteworthy production, it should be pointed out that there have been numerous discoveries of other deposits of various kinds. Some of these are small; others are of larger size but of a grade which is marginal under the present conditions. In 1937, Stockwell described seventeen claims and prospects in the vicinity of Herb Lake, and, in 1949, Harrison described no less than thirty-two similar properties from the File Lake and Tramping Lake areas. These descriptions cover a variety of gold, nickel, molybdenite, and other sulphide deposits. For detailed information, one should refer to the original memoirs.

In 1929, diamond-drilling was done at the *Ruby* silver-lead property, situated a few miles west of the north end of Herb Bay.

The deposit is in quartzite and thin beds of mica gneiss, cut by small bodies of quartz and pegmatite. High values in lead, silver and zinc were obtained in trenching. The mineralized zone contained pyrrhotite, pyrite, arsenopyrite, chalcopyrite, sphalerite, and galena.

Several pegmatite dykes are reported to occur in the area, and to contain considerable quantities of lithium minerals, principally spodumene, although lepidolite, amblygonite, and triphylite have been reported. Masses of beryl have been taken from some of these dykes.

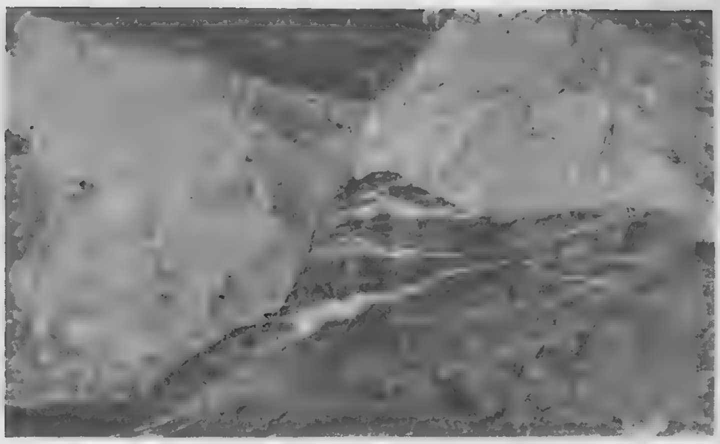
A notable occurrence of spodumene was discovered near *Crowduck Bay* in 1931. Diamond-drilling was undertaken by Sherritt Gordon Mines Limited during the summer of 1942, on this occurrence. Information gained from the drilling of twenty holes indicated an average spodumene content of 13.76 percent over an average horizontal width of 18.6 feet for a length of at least 900 feet. One hole drilled to a depth of 175 feet confirmed the continuity of the dyke to that depth. The lithia content of the spodumene in this occurrence varies between six and seven percent.

The *Rice Island* copper-nickel deposit occurs in a medium-grained black or greenish black quartz gabbro of massive appearance. The principal mineralization is in rock that is schistose, joined and brecciated. It is exposed at the south end and along the west shore of Rice Island. Quartz gabbro does not outcrop on the neighboring islands east and west of the deposit; nor, apparently, does it extend far under the lake beyond the island as most of the drill cores passed through quartz gabbro into the surrounding greywacke, slate and chlorite and talcose schists.

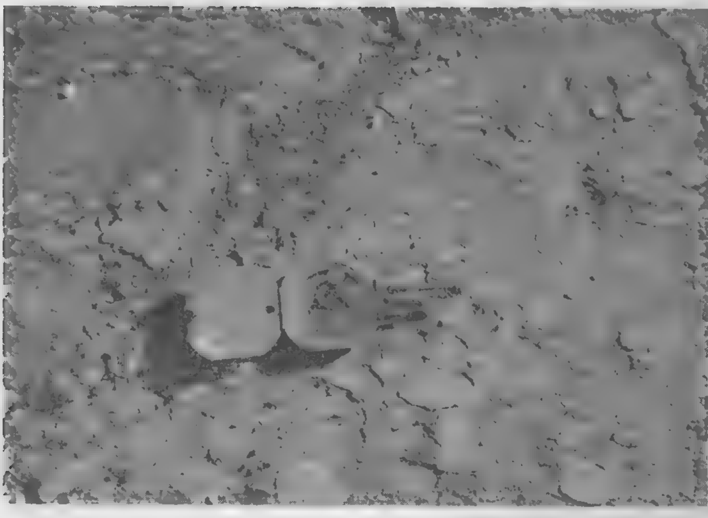
The north shore of Herb Lake is also interesting in that it contains considerable areas of mineralized medium- to coarse-grained quartz gabbro containing values in nickel and copper. Exposures of this rock outcrop on the Copper Dome, Arctic, West, Chalco and Mundic groups of claims on most of which considerable trenching has been done. In most of the showings the combined copper-nickel content is low, but in some places reaches four or five percent over narrow widths.

Molybdenite occurs on Crowduck Bay, on Grass River near the outlet of Herb Lake, and on the north arm of Herblet Lake. *Galena* and *sphalerite* have been reported to occur in a quartz-impregnated shear zone in greenstone on the south shore of Snow Lake.

During the year 1942 a number of occurrences of *scheelite*, associated with quartz veins in granitic and volcanic rocks, were discovered. From one of these, the old Apex property



Fault displacement across quartz vein 625-foot level
Laguna Gold Mine, Herb Lake.



Foot-wall conglomerate, Laguna Gold Mine, Herb Lake.

a shipment of 3,000 pounds of scheelite was made to the Mines Branch Laboratory at Ottawa, by J. Nutt and associates.

In the File Lake district, according to Harrison, most of the deposits are within two miles of the granite mass that surrounds Ham Lake, and nearly all are in, or adjacent to, shear zones. In this connection special attention should be given to contacts, as some of the shears may be due to slipping of one member past another during folding. No ore has been found between Woosey Lake and Morton Lake.

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REED LAKE AREA

The Reed Lake area surrounds Reed, File, Morton, Loonhead, and Woosey Lakes. Reed, the largest lake, one of the expansions of Grass River, lies about 25 miles due west of the south end of Herb Lake, and about 35 miles due

east of Cranberry Portage on the Canadian National Railway (The Pas-Flin Flon).

The area is reached by canoe from Cranberry Portage via the Cranberry Lakes, Elbow Lake, Iswasum Lake, Loucks Lake, and intervening stretches of the Grass River. Six short portages are made en route. The trip takes from one to two days' easy travelling.

A second route leads from Herb Lake up the Grass River via Tramping Lake to Reed Lake. Two portages, one of 23 chains and the second 15 chains, as well as several short ones. are crossed during the trip, which takes but a few hours. A wagon road, 4 miles long, leads from the most northerly tip of Reed Lake to Morton Lake. A short portage leads from Morton Lake into File Lake, and File River leads into Loonhead Lake. Woosey Lake may be reached by ascending a stream that empties into the east bay of Reed Lake.

General Geology

Whereas Ordovician limestone overlies most of the area south of Reed Lake, Precambrian lavas outcrop to the west and north of the lake and extend as a belt several miles both east and west of Morton Lake to File Lake and to the south shore of Loonhead Lake. The lavas also extend eastward from Morton Lake through Woosey Lake to the shores of Tramping and Herb Lakes. The lavas include rhyolite, basalt, and andesite with intercalated tuff, chert, and carbonate beds. Dykes of pegmatite, granite, granite porphyry, gabbro, and black lamprophyre cut the lavas. Wide zones of chlorite schist have been developed in some localities.

Sediments outcrop north of File Lake, and north and west of Loonhead Lake, and extend through Limestone Point and Walton Lake to the Kississing Lake area. They are grey and black quartz-mica gneisses of the Kisseynew series.

Mineral Occurrences

The Reed Lake area has been prospected at intervals for over thirty years, with the greater part of the activity being confined to the last fifteen years. Claims have been staked, and work done, upon gold-bearing quartz veins and sulphide deposits.

The best known of these are the North Star and Gold Shower groups, located about 6 miles west of Morton Lake. The veins occur in belts of chlorite schist in a massive black medium-grained andesite about a mile east of its western contact with the granite. Pyrite, chalcopyrite, sphalerite, and galena occur sparingly in the quartz. Free gold is sporadic in its occurrence.

Since 1927, when the original deposit was discovered, considerable development work has been done on the properties by various interests.

According to Wright, *the belt of volcanic rocks surrounding the North Star deposit and extending northward from the west end of Reed Lake appears to be a promising area wherein to prospect for gold-bearing deposits.*

In 1928 and 1929, claims were staked at Loonhead Lake and at Jackfish Lake, just north of the centre of Reed Lake. On Loonhead Lake the deposits occur as mineralized zones containing pyrrhotite, pyrite, and a little chalcopyrite, in mica gneisses and schistose andesites. At Jackfish Lake sulphide bodies occur in quartz gabbro.

Work has also been done on several quartz showings that occur in lavas outcropping on the south shore. Prospecting should be centered in those areas where schistose belts of lava are intruded by small bosses of granite and granite porphyry.

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ELBOW LAKE AREA

Elbow Lake, an expansion of Grass River, lies about 30 miles northeast of Cranberry Portage on the Canadian National Railway (The Pas-Flin Flon).

The canoe route to the area traverses the Cranberry Lakes and a six-mile stretch of the Grass River. The only portage is over a one-mile wagon road from Cranberry Portage to the First Cranberry Lake. The trip is usually made in five to six hours by canoe and outboard motor. Because of the location on one of the well-travelled water routes of the north, Elbow Lake has been visited by many prospectors.

General Geology

The area of lavas and schists on, and about, the lake is about 6 miles wide and 12 miles long. The volcanic rocks include flows of andesite and basalt, together with intercalated beds of tuff-like materials. Hornblende, chlorite, and sericite schists developed by shearing of the lavas and tuffs, occur in wide areas. The sedimentary members include quartzite and arkose, and derived quartz-mica gneiss and staurolite schist. Some of the gneisses are garnetiferous. Granite rocks, in small bosses and dykes, cut the lavas and sediments and have, for the most part, developed gneissic and schistose features.

Mineral Occurrences

The gold deposits are of two types, concentrated mainly about Elbow Lake and west of Morton Lake. One type, of minor importance, consists of sulphides without appreciable vein quartz; the other is the more usual type of quartz vein.

The quartz commonly occurs in shear zones in lava, or follows the cleavage of the lavas. The lavas, here, commonly occur as chlorite schist. The quartz forms stringers and lenses, with patches of schist as inclusions, and the veins

are usually near the "quartz-eye" granite. A few of the veins may be related to the later granitic intrusions. Some carry abundant free gold.

According to Stockwell: "*Prospectors should concentrate their efforts on areas of lava about bodies of "quartz-eye" granite, or in areas where the lavas are cut by dykes of porphyry or rhyolite that are related to this granite. Especially favourable localities are where the granite contact crosses the cleavage of the lavas at a large angle.*"

Early Developments

Some claims are reported to have been staked on Webb Creek, at the north end of the lake as early as 1916, but it was not until gold was discovered at the south end of the lake in 1920 that the main activity commenced. The *Murray* group of claims is located on Grass River at the outlet of Elbow Lake. In 1921 considerable surface work was done on this group, including trenching, sinking two prospect shafts, 25 and 60 feet deep, and 50 feet of drifting, before operations were suspended. Additional work of an intermittent nature has been carried on from time to time.

Other properties that have been prospected extensively by trenching and by prospect shafts are the *Sherlock*, *Webb-Garbutt*, *Mack*, and *Hanna*. Most of these occurrences are in shear zones in andesitic schists. Many other deposits are known in the area. Detailed descriptions of individual properties in the area may be obtained from Stockwell's report listed in the references.

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CRANBERRY, COPPER, AND BRUNNE LAKES AREA

The three Cranberry Lakes extend northeast from Cranberry Portage for a distance of about 20 miles. Copper and Brunne Lakes lie north of Second Cranberry Lake and within four miles of the Sherridon branch of the Canadian National railway. Both winter and summer routes to the latter lakes leave the railway at Mile 12.

General Geology

Belts of Amisk lava of rather restricted extent form the attractive prospecting ground of the area. The lavas are cut by granite, granite porphyry, and pegmatite. Recrystallization of the dense volcanic rocks to rocks possessing a much coarser grain appears to have taken place along the margins of the intrusive granite. *Tuff-like bands of sedimentary rock are included within the volcanic series and should be prospected carefully, especially where fine-grained dykes of granite porphyry are seen to intrude this type of formation.*

The largest belt of Amisk formation with a maximum width of three miles lies to the north of the narrows between Second and Third Cranberry Lakes. Another belt of rather limited extent surrounds Copper and Brunne Lakes. The mineralization was attributed by Hage to the pink granite of the district.

Mineral Occurrences

Attention has been directed by Wallace to the type of sulphide mineralization found in the vicinity of Copper and Brunne Lakes. "Some idea of the extent of this iron sulphide mineralization may be obtained from the fact that on the Caribou claim west of Brunne Lake a rounded hill is well exposed on the line of strike of the iron formation at least 75 feet wide and is mineralized throughout with practically solid pyrite and pyrrhotite." The sulphide bodies are reported to contain some gold, copper, nickel, and platinum.

Gold occurs in quartz veins in association with sulphide minerals. The most important development was that on the Dominion group of claims (*Gurney Gold Mines Limited*) between Copper and Brunne Lakes. The gold values of this property occurred in a sheared tuff-like band in the volcanic rocks. The vein was developed by the replacement of much of the sheared tuff by quartz and consisted of a mosaic of rock fragments and stringers of blue quartz. The mineralization consisted of abundant pyrite, some galena, chalcopyrite, and gold. The vein was irregular in width, striking north 42 degrees east and dipping 75 degrees to the northwest. During the years 1937 to 1939 the mine produced a total of 25,164 ounces of gold and 71,593 ounces of silver valued at $894,128 and $30,291, respectively.

Prospectors in this area should be cautious as to the reliability of panning test for gold values. It has been noted that where the gold is very finely divided only about one-third appears in the pan. With existing gold prices, important showings may be neglected if only the panning method of estimation is used.

Early Developments

The area was one of the first to be visited by prospectors in northern Manitoba and it has been prospected at intervals ever since. Many of the mineral occurrences were known for several years before 1928 but it was not until that year that the first attempts at development took place. In 1928 some diamond-drilling was done on a deposit of chalcopyrite in small shear zones north of Cranberry Portage and a sulphide body near the northeast end of Second Cranberry Lake was also explored. The latter deposit, which was discovered in 1928, consists of some chalcopyrite distributed through pegmatite and adjoining lavas.

In 1928 and 1929 considerable surface work was done on a number of sulphide bodies near Copper and Brunne Lakes and some of these bodies were diamond-drilled.

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ATHAPAPUSKOW LAKE AREA

The Athapapuskow Lake area lies mainly along the north shore and around the north arm of Lake Athapapuskow. It includes the basins of Neso, Nisto, Payuk, Twin and Thompson lakes and the belt of schists which extends along Pineroot River to Mikanagan Lake. The approximate limits of the area are latitudes 54 degrees 30 minutes, to the south, and 54 degrees 50 minutes, to the north and the Manitoba-Saskatchewan boundary to the Cranberry Portage-Sherridon branch of the Canadian National railway west to east.

The Flin Flon branch of the railway parallels the north shore of the main lake for 18 miles and during the summer months prospectors leave the railway either at Cranberry Portage, Mile 51, where supplies and equipment can be secured, or at Athapap, Mile 66, which is the closest railway point to the north arm and west end of the lake.

General Geology

Owing to its location on one of the principal canoe routes north of the Pas, Lake Athapapuskow has been crossed and recrossed from the earliest times. Tyrell noted the occurrence of Precambrian schists along the shores of the eastern part of the lake in 1896 and Dowling described in detail the geology of the North Arm and Pineroot River areas which were mapped during his trip to Kississing and Churchill Rivers in 1899. Being the closest Precambrian area to The Pas it was probably one of the first to be looked over by prospectors in northern Manitoba.

The promising ground for prospecting in the Athapapuskow Lake area consists of Amisk volcanics and Missi sediments which have been metamorphosed largely into schists. The volcanics include black and green andesite and grey rhyolite.

Large areas are altered to an aggregate of chlorite, sericite, epidote, and carbonates. The lavas are porphyritic in places and may be interbedded with agglomerates and coarse pyroclastic beds. The Missi sediments are metamorphosed conglomerate, arkose, and greywacke. Both lavas and sediments are cut by later intrusions of granite and granodiorite. The larger of the schist areas comprising the most promising prospecting field, surrounds the north arm of Lake Athapapuskow.

Mineral Occurrences

During the period of 1915 to 1920 the area received some careful prospecting, and many sulphide bodies were discovered on Pineroot River, on the east arm of Lake Athapapuskow, at Twin Lake, and at Thompson Lake. Considerable work was done on several of these bodies and near the mouth of Pineroot River the Chica claim was explored by diamond-drilling during the summers of 1918 and 1919. According to Wallace:

"The characteristic of this district is the widespread occurrence of chalcopyrite . . . in schisted bands in the greenstone . . . while only occasionally . . . have quartz veins been discovered with indications of gold values."

Early Developments

In 1922 the Baker-Patton copper-sulphide deposit, situated at the extreme north end of Sourdough Bay, a northeast branch of the north arm of Lake Athapapuskow, was held for a short time under option.

In 1926 and 1927 five holes averaging 400 feet in depth were diamond-drilled on the deposit. During 1928 a development plant was taken in from The Pas and a three-compartment shaft was sunk to a depth of 418 feet, cutting stations at the 150-, 275-, and 400-foot levels. A total of 630 feet of drifting and crosscutting was done at these levels. Operations were suspended in December, 1928. During the winter of 1929-30, 4,799 feet of diamond-drilling were done on this deposit.

The Baker-Patton deposit is in a belt of cherty and tuff-like rocks lying between thick flows of schistose acidic lava. The main sulphide zone consists of black slaty ash-like rocks

and chloritic schists which are heavily impregnated with pyrite and small quantities of chalcopyrite.

Twenty-eight hundred feet of diamond-drilling were done on a group of claims between Sourdough Bay and Thompson Lake and in 1929 a deposit on the Don Jon mining claim was diamond-drilled. The latter deposit is on an island in Thompson Lake, and consists of sulphides along limy beds between thicker, more massive quartzose chlorite-carbonate schists which probably represent beds of quartzose and limy sediments within the lavas. At the south end of the island the sulphide-bearing zone is about 50 feet wide but it narrows to the north. Considerable chalcopyrite is present in some parts of the deposit.

Late in 1929 the Billy Boy group, situated near Mink Narrows, North Arm, was optioned following a discovery of gold on one of the claims. The property was carefully prospected during 1929 and 1930. Gold was found to occur in quartz stringers up to 4 inches in width in a basic granodiorite which is intrusive into the lavas. The granodiorite which is slightly sheared along joint planes carries pyrite and a little chalcopyrite in places along the shear zones. In 1931 some diamond-drilling was done on the deposit but no workable orebody was brought to light by the exploration work.

Some trenching was done in 1930 at the Var group on an outcrop of sulphide-bearing schist which appears on a small island to the southeast of the Billy Boy claims. Widths up to 10 feet assayed about 2.5 per cent copper. The deposit could not be trenched for any distance, however, because of its proximity to the water's edge. Diamond-drilling would be necessary to determine the continuity of the body under the lake.

Interest has recently revived in this area. Diamond-drilling by Hudson Bay Mining and Smelting Co., Limited has proven the existence of 156,000 tons of 6.78 per cent copper ore at Thompson Lake. The company, in 1951, was preparing to go underground.

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SCHIST-FLIN FLON LAKES AREA

The Schist-Flin Flon Lakes area comprises a belt of Precambrian rocks which extends along the Manitoba-Saskatchewan boundary from the seventeenth base line northward for a distance of about 20 miles. It includes the basins of Schist, Ross, Flin Flon, Embury, and Tartan Lakes, and lies mainly in townships 65-68, range 29, west of the Principal meridian.

The area is easily reached from the Flin Flon branch of the Canadian National Railway which runs along the east shore of the northwest arm of Schist Lake, the east shore of Ross Lake and terminates at the town of Flin Flon on Flin Flon Lake, about 87 miles by rail north of The Pas.

General Geology

The rocks exposed in the area are for the most part Amisk volcanics which are interbedded with thin layers of sediments and are cut by small bodies of gabbro, granodiorite, granite, and granite porphyry. All the volcanic rocks are more or less schistose, and some have been altered to chlorite schists by extreme metamorphism.

Mineral Occurrences

Many sulphide bodies are found along the contacts of small granite intrusions with the chloritic greenstone and greenstone schist. In such bodies the sulphides are chiefly pyrrhotite or pyrite, but none has been found to contain enough nickel or copper to make it important. The valuable

lenses lie some distance from outcrops of igneous rocks but not too far from actually exposed bodies to make their genetic connection with the intrusions seem improbable.

The area contained two notable orebodies, discovered in the early days of prospecting in northern Manitoba, the Flin Flon and the Mandy copper-zinc sulphide deposits, and both have made significant contributions to its mining history. The area contains two other copper-zinc occurrences, the Schist Lake mine and Cuprus mine, which have only reached the development stage in recent years.

News of the Flin Flon discovery did not reach far until late in 1915. It attracted a number of prospectors to the immediate area and led to the discovery of the Mandy orebody by Fred Jackson and Sidney S. Reynolds in October of the same year.

The Schist-Flin Flon Lakes area has been prospected at intervals ever since the original discoveries were made, and a number of other sulphide bodies have been found and staked in the vicinity of the north and northeast arms of Schist Lake and east of Ross Lake. Considerable work has been done on the Iron Horse group on the Canadian National railway at Mile 78.

In the northeastern part of the area a few prospectors have been actively engaged in exploring gold prospects at Tartan Lake. During 1932 a number of claims were staked in this area and several shipments of gold-quartz ore were sent to the smelter at Flin Flon from one of them, the Ruby claim.

Mandy Mine—The Mandy was the first deposit in the entire area to undergo development. It was optioned soon after discovery and was diamond-drilled in the summer of 1916. Incidentally, this was the first diamond-drilling in northern Manitoba and revealed an orebody containing 25,000 tons of massive chalcopyrite averaging about 20 per cent copper and containing gold and silver to the value of about $5.00 per ton, together with additional lower grade ore.

Owing to the high price then prevailing for copper, it was decided to mine and ship the massive chalcopyrite ore by a combination of team haul, water transportation, and rail to

The Mandy, Manitoba's first important producer of metals
Schist Lake, 1916.

the smelter at Trail, B.C. During the period of 1917 to 1920, inclusive, there was mined and shipped about 25,000 tons of ore, which produced 9,866,328 pounds of copper valued at $2,039,943, with additional values of $5.00 per ton in gold and silver.

An extensive campaign of underground development was carried on at the property in 1928 and 1929. The shaft was deepened to 1,025 feet, with levels below the old workings at 100-foot intervals from 325 feet down. Lateral work was done at all levels and, in addition, considerable diamond-drilling from underground stations. Operations were suspended late in 1929 to await better prices for copper. In the year 1943, under the pressure of wartime requirements, operations at the Mandy mine were resumed on a 200-ton daily basis under the direction of Emergency Metals Limited, a subsidiary of Hudson Bay Mining and Smelting Co., Limited. The company operated under contract with the Metals Reserve Company, an organization created in 1940 by the United States government for the procurement of strategic mineral supplies. Copper and Zinc concentrates were prepared for shipment.

In its second period of operation the mine produced 125,021 tons of an average grade of 5.47 per cent copper, 16.5 per cent zinc, 0.095 ounce of gold, and 1.9 ounces of silver. Operations were discontinued towards the end of 1944.

The Mandy deposit was in a band of schist with massive greenstone on either side. It was 225 feet long and had a maximum width of 40 feet. It dipped from 75 to 80 degrees to the east and pitched at a high angle to the south. The chief minerals were pyrite, which was the most abundant, sphalerite and chalcopyrite in important quantities, and minor amounts of galena and arsenopyrite. Gold and silver contributed important values.

Several similar, but small, bodies have been discovered in the district.

Flin Flon Mine Discovery—The Flin Flon orebody was the first discovery in the area. Because of the importance of the Flin Flon mine the story of its discovery is offered in some detail.

The find was made in January, 1915 by Thomas Creighton who had a camp at the time at Phantom Lake, a few miles south of what was later to become known as Flin Flon Lake. He was one of a party of six prospectors in the Beaver Lake area for John Hammell of Toronto, Ontario, and associates. Four of the party, Leon Dion, the two Mosher brothers, and Creighton, combined trapping in the winter and prospecting in the summer. Leon Dion was camped in the neighborhood and the Moshers were in the Beaver Lake area.

On the day of the discovery, Creighton was circling through the country looking for fur signs, sizing up the rock formations and hoping to see a moose that he could shoot for fresh meat. His wanderings took him in sight of the lake (there were then no maps of the country) and he went down to its shore. On a point where there was an outcrop the snow had been blown clear enough to show chalcopyrite in the schist. Creighton saw the mineralization and decided that it was worth further examination.

When the snow was gone in the spring of 1915, Creighton returned for that purpose in the company of Jack Mosher. Together they decided that the prospect was worth staking, and on August 15, 1915, after a further examination, they staked the first two claims and then went to Beaver Lake where other members of the party were camped. After staking sixteen claims the party returned to Beaver Lake and informed Hammell of the find.

The name "Flin Flon" was derived from a character in a book, "The Sunless City," which Creighton, Leon Dion, and the two Moshers had found on a portage while travelling from Churchill River to Lac la Ronge in the summer of 1913.

Early Developments at Flin Flon Mine—Hammell examined the property and subsequently interested Hayden-Stone, Boston, Massachusetts, and associates, with the result that further exploration work, including diamond-drilling, was soon under way.

During 1916, 6,000 feet of diamond-drilling were done on the property in an attempt to estimate the main orebody but agreement with the owners as to terms was not reached, and work was suspended. In 1917 the Fasken interests of Toronto commenced diamond-drilling and continued until July, 1918, drilling in all 44 holes, representing a total of

Camps No. 2 Shaft Test Mill Power Plant

Aerial view of early development at Flin Flon Mine, 1928.

25,664 feet. At this stage the possibility of recovering zinc values was problematical. In 1920, R. E. Phelan came to Flin Flon to study direct smelting of the ore. At the same time underground development was carried on, totalling 1,892 feet of sinking, cross-cutting and drifting, for the purpose of test-sampling the ore and to confirm the diamond-drilling results.

In November, 1925, Mining Corporation of Canada interested Minerals Separation Company, representing the Whitney interests of New York, with R. H. Channing, Jr., conducting the negotiations. Metallurgical experimentation was carried on until 1928 and when a satisfactory process for extraction of the metals was worked out, Hudson Bay Mining and Smelting Co., Limited, was incorporated to develop and operate the Flin Flon mine.

A railway was built by the Manitoba Northern Railway Company with the assistance of the Government of Manitoba in the form of guarantees, from The Pas to Flin Flon, a distance of 87 miles. Steel reached Flin Flon in October, 1928, and furnished the means of transportation for great quantities of construction material, equipment and supplies to that point for the mining and metallurgical plants, and also for a hydro-electric plant to be constructed at Island Falls on Churchill River, 56 miles to the north. During the winter of 1928-1929, 25,000 tons of material were hauled by sleighs and Lynn tractors over 69 miles of iced winter roads to the power site where, until July, 1930, 800 men were employed in the construction work.

At Flin Flon, excavation work to the east and northeast of the orebody was started early in 1929, and the end of the year saw completion of most of the foundation work for the hoisting and crushing plants, flotation and cyanide mill, zinc roasting, leaching and electrolytic plants, copper smelter, power houses, bedding bins and coal-pulverizing plants. Together with these, extensive preparations were made for mining both in open-pit and underground. As a considerable part of the ore lay beneath a bay at the southeast end of Flin Flon Lake, plans were made to dam off this bay and pump out the water. A five-compartment main shaft, 15 by 22 feet excavation, was started centrally along the orebody at a location 400 feet to the east of the hanging-wall.

A transmission line from Island Falls to Flin Flon was completed early in 1930 and made hydro-electric power available for testing and operating the various plants. By December, 1930, after plant adjustments had been made, the regular production of blister copper was started. Early in 1931 a daily mine tonnage of 3,000 tons of ore was attained. This rate was maintained until about June, 1932, when the daily mine output was stepped up to 4,400 tons. During the year 1944, a daily output in excess of 6,000 tons was being hoisted. During 1950, the mine output was about 5,000 tons a day.

The original orebody blocked out to a depth of 900 feet was estimated to contain 18,000,000 tons, averaging: copper, 1.7 per cent; zinc, 3.45 per cent; gold, 0.074 ounce; silver, 1.06 ounces a ton.

At January 1, 1950, or after 19 years of production, the ore reserves of the mine were estimated at 20,157,000 tons averaging: copper, 3.04 per cent; zinc, 4.34 per cent; gold, 0.084 ounce; and silver 1.14 ounces a ton.

Since 1940 the sinking of the South Main shaft (in Saskatchewan) to a depth of 4,000 feet has been completed, and an exploration winze has been sunk to over 4,800 feet. A crusher was installed at the 3,750 level.

Flin Flon Orebody—According to Brownell, much of the Flin Flon orebody, and perhaps all of it, lies in sheared quartz porphyry which occurs presumably in the form of a dyke between beds of steeply-dipping andesitic lavas and other volcanic rocks of the Amisk series. The sheared porphyry, especially on the foot-wall side, has been largely replaced by chlorite to form chlorite schist, or even massive talc, or it has been silicified. In this manner much of the quartz porphyry has been destroyed or replaced to such an extent that the resultant rock bears no resemblance to the original porphyry.

The features associated with the ore are: (1) shear zones cutting (2) quartz porphyry and Amisk volcanics, together with minor anticlinal folds. The effects of the wall-rock on ore deposition appear to have been physical rather than chemical—through the different behaviour of the different rocks when sheared.

The orebody is a fairly regularly shaped lens tapering gradually to the northwest and ending rather bluntly to the

southeast. It strikes 30 degrees northwest and dips 60 to 70 degrees northeast. The boring records show that it pitches at a low angle to the south. The total length of the orebody on the surface was 2,593 feet, and its greatest width near the surface, with some inclusions of greenstone, was 400 feet.

The minerals in order of abundance are: pyrite, sphalerite, and chalcopyrite. Gold and silver occur, apparently associated with the pyrite. Cadmium, selenium, tellurium, and cobalt also occur but in lesser amounts. The ore comprises two types, the one a solid sulphide, and the other a disseminated sulphide, with the former assaying higher in zinc and gold but lower in copper than the latter.

Surface Oxidation—An extremely noteworthy description of the surface oxidation of the Flin Flon orebody has been made by Brownell and Kinkel and as it is the oxidized zone that first attracts the prospector, the description of the occurrence may be quoted in full:

"Oxidation was confined to within a few feet of the surface, where the only concentration of values took place. There has been little indication of any underground circulation of water, although there are numerous joints and fractures traversing the ore. Lack of oxidation underground is attributed to the cold condition of the surface water which, during fully half of the year, is in the form of ice. In fact, it is quite probable that much of the muskeg and clay overlying the ore remained frozen through the year, thus minimizing the amount of water free to circulate.

"Another factor tending to prevent surface weathering was the blanket of thick beds of fine, black, rubbery lake and glacial clays that immediately overlay much of the ore. This acted as a more or less impervious layer and only at one place, the original discovery point, did the sulphide body penetrate this clay. Here the ore was thoroughly oxidized and contained important concentrations of gold and silver. This oxidation is thought to be post-Glacial, as the oxidized area was in an elevated and exposed position; had it been pre-Glacial, it is difficult to conceive how such a soft mass could escape being scraped down level with the enclosing rock. The rock and solid sulphide enclosing this small oxidized area were highly polished and striated by glacial

action; even the depression scooped out of the ore by the glacier several hundred feet to the southward, and which is 80 to 100 feet lower in elevation, displayed a striated and unoxidized surface.

"The oxidized area was carefully mapped and sampled because of its high gold and silver content. It was found to consist of fairly regular layers, yellow, red, white, and purplish in colour, and composed of limonite, quartz, and clayey material. In thickness this ranged from one to ten feet and it was generally overlain by one or two feet of sandy muskeg. Pits dug in this area revealed, in some places, a fairly sharp contact between the solid sulphides and oxidized material, but generally the contact was found to be gradational from the clayey limonite to solid sulphides. The transition zone was soft and sugary, grading into normal, hard, solid sulphide within two or three feet.

"The gold content of the oxidized zone was for the most part uniform, and the soft transition zone carried high values for a foot or two below the clay. Some of the yellow clay carried no gold, however, though it could not be differentiated by visual inspection from that which did; but subsequent churn-drilling revealed that such barren areas were underlain by disseminated ore which carried no gold values. Sampling showed that only over the solid sulphide did the oxidized zone carry gold and silver, proving very definitely that concentration of values was the result of residual enrichment. Proceeding along the strike to the north and to the south from the outcrop, the oxidation extended for distances varying up to one hundred feet beneath the clay, with values decreasing as the thicknesses became less. *As a matter of interest to prospectors, it may be noted that tests made on the oxidized material revealed that only 15 to 20 per cent of its gold content could be recovered by panning, a result due presumably to the extreme fineness of the gold.*

"The copper and zinc in the solid sulphide was almost entirely removed by oxidation, and the leached sulphides for several feet below the clay carried no copper or zinc. There was only a partial concentration of values lower down, forming a zone of enrichment, because the solutions could not penetrate the massive sulphide ore; but wherever bands of talc occurred in the sulphides, or over the disseminated

ore, there was a considerable chalcocite enrichment, up to 20 feet in thickness. No secondary zinc minerals were noted.

"In addition to the chalcocite enrichment of the talc-chlorite bands, some of the copper removed was deposited as native copper in dendritic form in cracks within the blocky, unsheared, waste-horse masses and in the hanging-wall, but not along shear planes. In the black clay above the ore there was a small amount of a mineral which appeared to be cuprite and which occurred as small, round, red spots in the clay, generally about one-eighth to one-quarter of an inch in diameter. Under the microscope, these were found to have a radial fibrous structure similar to that observed elsewhere in cuprite crystals in gypsum and clay. Gypsum was abundant in the clay, forming divergent clusters of crystals up to 8 inches in diameter.

"The lead was also concentrated in this zone of enrichment, assays as high as 3½ per cent being obtained.

"A comparison of the assay of the oxidized material and of the 20-foot thickness of massive sulphide immediately below showed that the oxidized zone carried approximately nine times as much each of gold, silver, and lead, as was present in the underlying sulphides."

For a full description of the history of development, construction of plant and operations of Hudson Bay Mining and Smelting Co., Limited, at Flin Flon, Manitoba, and Island Falls, Saskatchewan, the reader is referred to the Transactions of the Canadian Institute of Mining and Metallurgy, volumes 33 (1930) and 38 (1935).

Cuprus Mine—Cuprus Mines Limited in which Hudson Bay Mining and Smelting Co., Limited holds a majority interest, was formed in 1943 to develop the Thompson group of claims on the northeast arm of Schist Lake and production was commenced in the latter part of 1948.

During 1950 a total of 86,202 tons of ore was treated giving average assays of: 0.043 ounce gold; 0.94 ounce silver; 3.86 per cent copper; and 7.1 per cent zinc.

In addition to exploration drifts and stope development work done during the year, a total of 11,491 feet of underground drilling was completed to assist in outlining ore-bodies. Estimated ore reserves at January 1, 1950, were 245,000 tons averaging: 0.045 ounce gold; 0.91 ounce silver; 3.62 per cent copper; and 6.8 per cent zinc.

Flin Flon Mine and Townsite, 1950. *Manitoba Government Travel and Publicity Bureau*

Schist Lake Mine—In 1950 Hudson Bay Mining and Smelting Co., Limited commenced lateral development on the 150-, 300-, 400-, and 600-foot levels of the Schist Lake mine, three and one-half miles southeast of Flin Flon.

A total of 3,529 feet of development work was completed and 13,323 feet of underground diamond-drilling was carried out to assist in establishing the outline of the orebody.

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KISSISSING LAKE AREA

The Kississing or Cold Lake area lies about 90 miles due north of The Pas. Its southern boundary forms the northern limits of the Schist-Flin Flon and Athapapuskow Lakes area, which are approximately along the eighteenth base line. The area extends northwest to latitude 55 degrees 30 minutes north, westerly to the Manitoba-Saskatchewan boundary, and easterly to Takipy, Walton, and Nokomis Lakes.

The area is reached by the Cranberry Portage-Sherridon branch of the Canadian National railway which terminates at Sherridon. From Kississing Lake long bays reach out to make the greater part of the area easily accessible by canoe. The country southwest of Kississing Lake towards Mari Lake is low and swampy for many miles, but in the neighbourhood of the lakes in most parts of the area, rock exposures are generally abundant.

General Geology

The rock types adjoining parts of Kississing Lake and Kississing River were first noted by D. B. Dowling during his exploration from Athapapuskow Lake to Churchill River in 1899.

By far the greater part of the area is underlain by a thick series of sedimentary gneisses of Precambrian age, termed "Kisseynew gneisses," which was derived by metamorphism from sandstone, impure sandstone, and clayey arkose. The abundant members of the series are:

A light-grey gneissic quartzite which outcrops prominently along the tops of many ridges, and probably originated as beds of sandstone.

Quartz-biotite-garnet gneiss, fine- to medium-grained and greyish in colour. This rock is very abundant and widespread and is probably the metamorphic equivalent of an impure sandstone.

Hornblende-bearing garnet gneiss, a medium- to coarse-grained black rock which outcrops as bands in association with the other two above-described types. It is believed to represent clayey arkose beds originally or volcanic rocks of an intermediate type.

Lavas with sediments occur south of Walton Lake and in the basin of Nokomis Lake, and andesitic lavas outcrop at

Kisseynew and Fay Lakes. A few miles to the east and north of Kississing Lake the sedimentary gneisses are terminated by large bodies of granite.

The sedimentary gneisses are intruded by many sills and dykes of granite, aplite, and pegmatite and by large batholith-like bodies of granite. A few bodies of peridotite, gabbro, and diorite also intrude the gneisses.

Mineral Occurrences

The mineral occurrences of chief interest in the area are pyrrhotite bodies containing chalcopyrite and sphalerite. Of these the Sherritt-Gordon is the most important known deposit and the only one which so far has been developed to any extent. Its orebodies occur in a well-defined shear zone in thin-bedded quartzite gneiss along the contact with a band of very basic garnetiferous gneiss. The shear zone is more pronounced where the basic band is thickest, and both have been traced for a distance of over seven miles. Structurally the shear zone is located in the south limb of an overturned anticline, both limbs of which dip to the northeast. The orebodies strike northwest and have an average dip of from 45 to 50 degrees. They occur as two elongated lenticular bodies—the east orebody, having a length of 4,200 feet and an average width of 15.2 feet, and the west orebody, having a length of 5,800 feet and an average width of 15.5 feet. The ore is a rather coarse-grained mixture of pyrrhotite, pyrite, chalcopyrite, and sphalerite, with numerous rock inclusions ranging in size from grains the size of a pea, to blocks weighing several tons.

In the Kisseynew sedimentary gneisses the sulphide occurrences so far discovered are along local folds or near sharp bends in the direction of strike of the strata. The evidence to date suggests that detailed prospecting should be confined to the limbs of folds along the edges of thick competent layers, or schistose bands lying within more massive rocks, especially where these have been affected by minor folds and sharp bends in the strike.

According to Wright, the majority of the discoveries in the area are in a rectangle 10 miles wide extending northwest and southeast for about 25 miles. He suggests that this may only mean that more detailed prospecting has been done

in the small area surrounding the Sherritt Gordon property than elsewhere.

Early Developments

The first prospecting in the area was evidently done by trappers. One of these, Phillip Sherlett, a Cree Indian, is reported to have made the first discovery in 1922. White trappers and prospectors staked adjoining ground and, later, all claims were allowed to lapse except a few held by Carl Sherritt and David Burke. In 1924, Sherlett's lapsed claims were staked by Carl Sherritt and Richard (Dick) Madole who optioned them in October, 1925, to J. P. Gordon who in turn optioned the property now known as Sherritt Gordon to the Earle-Fasken interests of New York and Toronto.

In a few months following, these interests completed 5,000 feet of diamond-drilling in 28 holes, from the results of which an orebody of 450,000 tons was calculated to exist and to average 2.86 per cent copper, and 3.3 per cent zinc. The option was dropped in September, 1926.

Finally, in the summer of 1927, E. L. Brown and R. J. Jowsey became interested in the deposit and were the means of bringing the property to development through Sherritt Gordon Mines Limited.

Following the incorporation of this company, July 5, 1927, prospecting became very active in the area and many claims were staked adjoining the Sherritt Gordon holdings and on islands in Kississing Lake for several miles to the west. Early in 1928 a mining recorder's office was established at Cold Lake settlement. During 1928, prospects with showings of copper-zinc sulphides were discovered in the vicinity of Elken and Walton Lakes to the east and near Kipahigan Lake towards the northwest corner of the area. In the late autumn, showings of iron and copper sulphides were located near Fay and Vamp Lakes along the south boundary of the area.

Sherritt Gordon Mine.—After Sherritt Gordon Mines Limited was organized in 1927, active development of the property was undertaken immediately. Extensive diamond-drilling was followed by underground work in three localities. In 1929 a railway was constructed by the Manitoba Northern Railway Company from Cranberry Portage to the property.

a distance of 42 miles. When the line was completed, mining and milling machinery and construction material for the various plants were freighted in and plant construction and mine development were pushed to prepare the property for production at a rate of 1,800 tons daily. Later, when the plants were nearing completion, it was decided, owing to the drastic decline in copper prices, to operate only one of the three grinding and milling units and the mine was brought into production at this reduced capacity in March, 1931.

In June 1932, after operating continuously for over a year, the mine was closed down and all operations suspended owing to further unprecedented declines in the price of copper. During its first period of operation the mine produced 6,756 ounces of gold, 209,408 ounces of silver, and 24,647,569 pounds of copper. Following a period of approximately a year, during which time the mine and surface plant underwent alterations, improvements and development, production was resumed during the latter half of 1937. In 1943 production from the east and west orebodies averaged slightly more than 2,000 tons daily from which were produced copper and zinc concentrates for shipment. The east orebody was mined out in 1946.

During 1949 mine production was slightly less than 1,700 tons a day. During 1950 and 1951, the ore was drawn from pillars and sills as no new ore was located. The mine was closed in September, 1951.

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GRANVILLE LAKE AREA

Granville Lake, an expanded portion of Churchill River, lies east of the Manitoba-Saskatchewan boundary and about 180 miles north of The Pas. It is approximately 150 miles by water route from Sherridon, the northern terminus of the Canadian National railway. The journey by canoe takes four or five days, and the route, which commences at Cold Lake (Kississing) village, one mile west of Sherridon, crosses Kississing Lake and follows Kississing River to Flat Rock Lake. It then crosses Flat Rock Lake to Churchill River, which is followed to Granville Lake. There are twelve short portages on Kississing River with a total length of 102 chains, and three portages on Churchill River.

The area extends from north of Granville Lake to beyond Cockeram Lake, and from Barrington Lake, on the east, to the Saskatchewan border on the west. The distance between Granville and Cockeram lakes is about 40 miles; from west to east the area is about 75 miles wide.

The Granville Lake area was mapped on a four-mile scale during 1932, 1933, and 1935 by J. F. Henderson, G. W. H. Norman, and D. L. Downie, of the Geological Survey of Canada. Two geological maps, Nos. 343A and

344A, were issued in 1936. Since 1946, the Manitoba Mines Branch has mapped the belt of volcanics and sediments extending westward from Barrington Lake to the Saskatchewan boundary. The following reports have been published: 46-2, Lynn Lake; 47-3, Hughes Lake; 47-5, Farley Lake; 47-6, Barrington Lake; 48-4, Dunphy Lakes; 48-6, Sickle Lake. The following are in preparation: 49-4, Counsell Lake; 49-5, Lasthope Lake; 50-9, McGavock Lake; 50-7, Laurie Lake; and 50-8, Beau Cache Lake.

General Geology

The rock groups of the area, and their relationships, resemble those of the Kississing, Athapapuskow, Schist, Reed, and Wekusko Lakes region to the south. There is a group of older basic lavas and sediments, called the Wasekwan series, which is overlain unconformably by the Sickle series, composed of sediments. The whole is intruded by a series of igneous rocks ranging from norite and gabbro to granite. Kisseynew-type gneisses, similar to those underlying much of the Kississing Lake area, have been developed by metamorphism of the earlier sedimentary and volcanic rocks.

The following table gives the relationship of the major rock groups.

Cenozoic	Glacial		Lake clays and silts; sand and gravel; eskers, moraines, boulder clays.
PRE-CAMBRIAN		Post-Sickle Intrusives	Late basic dykes. Quartz-feldspar porphyry and felsite. Granite, diorite, quartz-diorite, and gneissic equivalents.
			Diorite, quartz-diorite granodiorite, gabbro, and amphibolite, norite.
		Sickle Series	Arkose, greywacke, conglomerate, and derived schists.
		Unconformity	
		Wasekwan Series	Mainly basic volcanics, with flow breccias, tuffs and iron formation. Interbedded sediments. Derived schists and gneisses. Minor acid flows.

The Wasekwan sediments and lavas extend from Barrington Lake to the Saskatchewan border; there are two roughly parallel belts, separated by later intrusives. These belts join in one or two places. Most of the lavas are fine grained, with small needles of hornblende; occasionally porphyritic phases are present. Acid lavas are relatively minor in quantity. The Wasekwan sedimentary rocks are mainly impure quartzites. The Sickle sediments overlie the Wasekwan series unconformably and form a belt, to the south of the lavas, from Lynn Lake to Laurie Lake, with an extension southwards from Sickle Lake to Granville Lake. The Sickle sediments are mainly brownish arkose and greywacke, with a distinctive conglomerate at the base of the series.

These rocks have been intruded by norite and gabbro, and some diorite and granodiorite which probably belong to the same period of activity. According to Crombie, some of the gabbro, at least, was formed by alteration of norite. Much of the area is underlain by granitic rocks younger than the gabbro and its associated types. An irregular zone of granite lies east-west between the belts of lavas mentioned above. Rocks as mafic as diorite are associated with these granites, so that there are diorites of at least two different ages within the region. Granite pebbles within the Sickle conglomerate may mean, also, that some of the granite is older than the Sickle series. In the southern part of the area the lavas and sediments grade into Kisseynew-type gneisses.

The Wasekwan series has been considerably folded in detail, but the regional structure is not definitely known. The Sickle series has been less severely folded. Large faults have not been recognized, although there are numerous small ones.

Mineral Occurrences

The mineral occurrences so far reported within the area are limited largely to the altered gabbro and to the greenstones, adjacent to granitic bodies. The most important discovery to date is the occurrence of nickel-bearing sulphides at Lynn Lake. Chalcopyrite, sphalerite, and pyrrhotite have been reported in minor amounts as disseminations and in quartz veins cutting the greenstones. Scattered occurrences of molybdenite have been noted in the granite, near

the margins of the bodies. Low values in gold have been reported from the vicinity of Lasthope Lake and McVeigh Lake, as well as from Laurie, Sickle, and Barrington lakes. Diamond-drilling by Sherritt Gordon Mines Limited has outlined a small medium-grade gold deposit at Lasthope Lake. Some gold was found in sheared volcanics near Muskeg and Gold lakes, in the Hughes Lake area. Chalcopyrite and sphalerite are reported from the volcanics, near gabbro contacts, on the south side of Barrington Lake. A few occurrences of gold have been reported from the more acid lavas; a quartz-porphyry dyke on the south side of Cartwright Lake has shown erratic high values in gold, and there is a possibility that such a body might be found which would develop into a low-grade, high-tonnage producer.

Nickel has been reported from the norite plug near Tow Lake, in the Barrington Lake area, where two small veinlets of massive sulphide have been found. The sulphides are usually disseminated. Nickel has also been reported from a basic plug south of Francis Lake, in the Lynn Lake district.

Lynn Lake—In 1941, Austin McVeigh, a prospector working for Sherritt Gordon Mines Limited, discovered nickel-bearing sulphides on the north side of Lynn Lake. Owing to the difficulties of obtaining equipment and labour during the war years, the discovery was not made known until late 1945. When it became known that the company was staking claims for nickel in the district, numerous mining companies and prospectors entered the area. Diamond-drilling done by Sherritt Gordon in 1946 and 1947 revealed the possibility of commercial nickel deposits in this area, and a staking "rush" developed. Although considerable exploration work was undertaken, Sherritt Gordon Mines Limited was the only organization to receive any appreciable encouragement. Consequently, by 1950 Sherritt Gordon was the only company actively operating in the Lynn Lake area.

By the end of 1950 Sherritt Gordon Mines Limited had outlined eleven orebodies by diamond-drilling with a total of just over 14,000,000 tons and an average grade of 1.223 per cent nickel and 0.618 per cent copper. A small deposit of 153,000 tons with a grade of 1.11 per cent copper, 2.49

per cent zinc, and 0.016 ounce gold had also been outlined. A five-compartment shaft was sunk to 1,024 feet and underground development conducted. A pilot mill at Lynn Lake produced nickel concentrate for a pilot leaching plant at Ottawa, Ontario.

During 1951 the company completed the financial arrangements necessary to bring the property into production. Work had also commenced on the 150-mile railway from Sherridon to Lynn Lake, which will serve the new mine. Provided that no unforeseen delays are encountered, nickel should be added to the Province's metallic production before the end of 1953.

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REINDEER LAKE AREA

Reindeer Lake lies on the boundary line between northern Saskatchewan and Manitoba, the greater part being on the Saskatchewan side. The portion in Manitoba lies between 57 degrees and 58 degrees north latitude and consists of Whitesand, Paskwachi, and Brochet Bays on the east side of the lake.

The nearest railway point to the area is Sherridon, from which it is reached by canoe across Kississing Lake and northwesterly over a route which is partly unmapped, to Wapus River into Reindeer Lake.

General Geology

Reindeer Lake was geologically explored by C. H. Stockwell in 1927, and the only outcrops of sedimentary and volcanic rocks mapped by him in Manitoba lie in the area around Paskwachi Bay and in a smaller area about 14 miles farther south in the vicinity of Whitesand River.

The sedimentary gneisses and schists of the area are similar to, and may possibly be correlated with, the Kisseynew sedimentary gneisses of the Kississing Lake area. They are intruded by white pegmatitic granite and pegmatite, and by sill-like bands of amphibolite which are also cut in places by granitic and pegmatitic material. The Paskwachi Bay area is the northeastern part of the large area of sedimentary and igneous rocks that surrounds the south part of Reindeer Lake in the province of Saskatchewan.

Mineral Occurrences

The copper-zinc deposit at Paskwachi Bay is a mineralized zone in a band of dark coarse-grained amphibolite which lies between grey gneisses. The zone has been traced for 800 feet by diamond-drill and values in copper and zinc were found over widths varying from 1 foot to 23 feet. Zinc is more abundant than copper and lead; silver and gold occur in small amounts.

REFERENCE

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RAT RIVER ROUTE FROM THREEPOINT LAKE TO SOUTHERN INDIAN LAKE, MANITOBA

Rat River is the canoe route which is regularly used by the Nelson House Indians who trap in the country surrounding Southern Indian Lake. The route lies approximately along longitude 99 degrees, 15 minutes west. The latitude of the mouth of Rat River where it enters Threepoint Lake is 55 degrees 40 minutes, and that where the canoe route enters Southern Indian Lake is 56 degrees 40 minutes.

The nearest railway point is Thicket Portage, Mile 185, on the Hudson Bay railway. From Thicket Portage a canoe route follows through Wintering and Paint Lakes to Ospwagan Lake, whence Manasan River is descended to Burntwood River.

General Geology

The rocks exposed along Rat River consist of Precambrian granites and gneisses with one small area of an older complex of sediments and volcanics. Exposures are not numerous because the area is largely covered by deposits of Pleistocene clays.

The pre-granite complex consists of a series of sediments and volcanics exposed on the western shore of Karsakuwryamak Lake, which is an expansion of Rat River about 30 miles southeast of Southern Indian Lake. The belt of sediments and volcanics runs in a northeast direction and pinches out immediately north of the lake. The greatest width of the

belt is about five miles. It is known to extend at least six miles west of the lake. The sedimentary part of the formation consists of finely banded gneisses and schists, and the igneous part consists of dark volcanic flows and pyroclastics which are locally altered to hornblende schist and are intruded by light-coloured porphyry and dark-coloured lamprophyre dykes.

Quartz veins are present in this complex but none is known of sufficient size to be of importance.

REFERENCE

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GRASS RIVER AREA

Grass River from Herb Lake east to Paint Lake and beyond to its junction with Nelson River near Split Lake closely parallels the Hudson Bay railway. It expands at several places to form lakes, and the larger of these, Setting, Paint, and Partridge Crop are easily reached from points on the railway.

The following lakes, which lie close to the river, are also for convenience included in the Grass River area: Wintering, which lies between Paint Lake and the Hudson Bay railway to the south, the station of Thicket Portage being situated on the lake shore; and Landing Lake, lying southeast of the railway at Thicket Portage.

General Geology

In the Grass River area the older volcanic and sedimentary schists and gneisses are limited to small areas within the granite. Bedded quartzite and greywacke outcrop along the west shore of Setting Lake for a distance of about 17 miles. North of the mouth of Setting Creek the sediments are at least two miles wide.

At Wintering Lake the rocks about the lake, in order of age from youngest to oldest, are, according to Wright, as follows: olivine diabase; granite, aplite, pegmatite; pyroxenite and gabbro; grey granite and syenite gneiss; and quartz-mica-garnet sedimentary gneiss.

The granitic gneisses are grey to black and contain small inclusions of garnet-rich sedimentary gneiss and of black chloritic schist. The pyroxenite cuts the complex of sedimentary and intrusive gneisses.

In the Partridge Crop Lake area grey quartzose and micaceous gneisses outcrop as small areas within granite gneiss and granite. Both the igneous and sedimentary gneisses are penetrated by dykes and small boss-shaped masses of pyroxenite and quartz diorite, and the gneisses and basic intrusives are cut by dykes of pink and white medium-grained granite and pegmatite.

Mineral Occurrences

During the period 1927 to 1929, a number of claims were staked at Setting, Wintering, and Partridge Crop lakes. In 1929, a sulphide deposit was diamond-drilled on an island near the east shore of Wintering Lake along the contact between pyroxenite and granitic gneisses.

The sulphide-bearing zone and pyroxenite are cut by pegmatite. *Pyrrhotite and chalcopyrite appear to be localized in small areas near these pegmatites.*

A second sulphide deposit of a similar nature occurs on a point on the northwest shore of the lake about two miles southwest of the outlet and was prospected during 1928. Chalcopyrite and pyrrhotite occur in small bodies within or near pyroxenite cut by pegmatite. Magnetite is very abundant in some zones in the pyroxenite.

In 1928 and 1929 a copper-nickel deposit on the lake about eight miles north of Mile 205, Hudson Bay railway, was explored.

Some galena and lesser amounts of sphalerite and chalcopyrite occur in the quartzite beds in this area.

REFERENCE

Wright, J. F.:
"Geology and Mineral Deposits of a Part of Northwest Manitoba;" Geol. Surv., Canada, Sum. Rept. 1930, pt. C, pp. 113-124.

OSPWAGAN LAKE AREA

Ospwagan Lake lies in the valley of Burntwood River immediately north of Paint Lake and is reached by canoe from Thicket Portage, Mile 185, on the Hudson Bay railway.

The route crosses Wintering and Paint Lakes and includes in order five portages of the following lengths: 53 chains; 1 mile and 13 chains; 8 chains; 1 mile and 10 chains; and 30 chains. The first three are between Wintering and Paint Lakes and the last two are between Paint and Ospwagan Lakes.

Ospwagan Lake area was geologically mapped in 1920 by F. J. Alcock. The rocks of the area are all of Precambrian age and consist of a belt of greenstone and tuffaceous rocks forming a narrow fringe on either side of Ospwagan and Little Pipe Lakes and extending northeastward to Burntwood River. These greenstone rocks have been to a large extent altered into hornblende schists by granite intrusions. According to Alcock the greenstone belt is narrow.

Mineral Occurrences

A nickel prospect in this area was diamond drilled by Central Manitoba Mines Limited and Canadian Nickel Company Limited, between 1947 and 1949, but the results obtained were not encouraging.

REFERENCE

Alcock, F. J.:
"Ospwagan Lake-Burntwood River Area, Northern Manitoba;" Geol. Surv., Canada, Sum. Rept. 1920, pt. C, pp. 1-6.

MYSTERY LAKE AREA

Mystery Lake lies about 17 miles northeast of Ospwagan Lake from which it is easily reached by descending Manasan River a distance of about 8 miles to Burntwood River, and then descending Burntwood River a distance of 9 miles to its junction with a stream that flows into it from the north. This stream is ascended 2 miles to Mystery Lake which is about 5 miles long and averages a mile in width to near the north end where two bays extend east and west from the main body of the lake.

General Geology

Lavas and sediments outcrop along the west shore of the lake whereas granite, containing many inclusions of sedi-

ments and volcanics, outcrops on the north and east shores. Later dykes of gabbro and diabase cut the older lavas, sediments, and granite rocks.

Mineral Occurrences

In 1927, a deposit of silver-bearing galena was discovered and staked by Gordon Murray on the west shore of the lake about 2 miles north of the outlet. The deposit occurs in schistose andesite adjoining a grey siliceous rock which may consist of recrystallized quartzose sediments injected with granitic material.

The schist zone varies from 2½ to 20 feet in width and galena and sphalerite occurs in small lenses of calcite and quartz along the schist zone for at least 450 feet. The zone of schist narrows to the north and passes under the lake to the south. The galena-bearing veins rarely exceed one foot in width or 100 feet in length, although one vein containing lenses and pockets of galena is 2 feet wide.

Some diamond-drilling was done on this deposit, but results obtained did not indicate that further work was warranted.

In 1949 it was discovered that the gabbro on the west shore of the lake contained nickel-bearing sulphides. The International Nickel Company of Canada, Limited obtained an option on the property and staked additional claims. Results from considerable diamond-drilling would seem to indicate the presence of a large low-grade nickel-bearing sulphide deposit.

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Wright, J. F.:
"Geology and Mineral Deposits of a Part of Northwest Manitoba;" Geol. Surv., Canada, Sum. Rept. 1930, pt. C, pp. 117-118.

SEAL RIVER AREA

Seal River rises east of the north end of Reindeer Lake and flows northeast for approximately 200 miles to enter Hudson Bay about 30 miles north of Churchill. The area

may be reached by air from Ilford on the Hudson Bay railway or by canoe from Sherridon, Wabowden, and Thicket Portage. The eastern section may be reached by canoe from Churchill, but travel upstream on Seal River is difficult as the rise from the coast in 110 miles upstream in 820 feet and rapids are numerous.

Much of the area is drift-covered but in the vicinity of Great Island, the most promising prospecting locality, rock outcrops and ridges are fairly numerous.

All of the area is underlain by Precambrian rocks. Highly folded sediments composed of beds of quartzite, mica schist, and conglomerate occur around and to the west of Shethanei Lake. The strike of these sediments is irregular and the beds dip steeply. The sediments are cut by large irregular masses, dykes, and sills of granitic rocks and numerous associated pegmatite bodies.

In the vicinity of Great Island the rocks consist of a series of highly-folded and metamorphosed volcanic rocks made up of rhyolite, andesite, and basalt, together with tuffs and agglomerates. These are overlain unconformably by sedimentary rocks, chiefly slates and quartzites. The sediments are folded along axes which strike north of east and plunge east usually at low angles. Folding is in places close but in others open and broad. Granitic rocks and dykes of quartz and feldspar porphyry intrude the volcanics. Areas of volcanic rocks occur for some distance eastwards down the river.

The most promising prospecting ground in the area would appear to be in the vicinity of Great Island and the country bordering the river channel east to Hudson Bay.

REFERENCE

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"A Geological Exploration on Seal River, Northern Manitoba;" Geol. Surv., Canada, Paper 35-2 (1935).

ASSEAN-SPLIT LAKES AREA

The Assean-Split Lakes area is contained in a rectangle approximately 38 miles by 35 miles in extent, in the southeast corner of which is Landing River or Split Lake station at Mile 279 on the Hudson Bay railway. This station serves as the starting point for canoe routes entering the area. The

main canoe route leads northwest from Mile 279, via Aiken River, a distance of 17 miles to Split Lake. From the west end of Split Lake the route, consisting of two portages with an intervening small lake, leads northward into Burntwood Bay near the southwest end of Assean Lake.

The greater part of the area is covered by a heavy mantle of glacial-lake clay so that with few exceptions, rock outcrops are confined to the shores of larger lakes and rivers.

General Geology

The area is underlain by rocks of Precambrian age consisting of sediments, lavas, intrusive gneisses, basic and younger granitic intrusives. With the exception of the last two types, the rocks have been highly metamorphosed, and most of them have a distinct gneissic character.

The sediments occur in belts which generally follow the basins of Assean and Split Lakes and are found for some distance along Burntwood River. Granite underlies a large portion of the area between the northeast part of Assean Lake and Assean River and Split Lake.

Mineral Occurrences

In 1928 a gold discovery was made in the vicinity of the west channel of Nelson River where it enters Split Lake In 1929 a group of claims was staked at the northeast end of Assean Lake.

Interest in the area dropped but was revived with the discovery of the "Lindal vein" on Assean Lake in 1936. During the following year the "Dunbrack vein" was discovered at a point about two miles southwest of the Lindal vein. Diamond-drilling has been done on both of these properties.

Mineralized occurrences have been observed elsewhere in the area. For the most part they are found within a broad belt running in a northeasterly direction through Assean Lake and extending along the upper part of Assean River, and at scattered points on Split Lake. The most common types of occurrences consist of cherty quartz veins and stringers containing sphalerite and galena; veins of grey glassy quartz

containing pyrite, pyrrhotite, and chalcopyrite; stockworks of quartz stringers accompanied by alteration and mineralization of the surrounding rock; and mineralized zones of schistose rock.

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"Assean-Split Lakes Area, Cross Lake Division;" Manitoba Mines Branch, Rept. 39-1 (1941).

Gill, J. C.:
"Waskaiowaka Lake Area, Cross Lake Division;" Manitoba Mines Branch, Publication 50-5 (1951).

CONCLUSION

The province of Manitoba has now enjoyed twenty years of active metallic production, marking a steady and sound growth in the mining industry.

The first metallic production recorded for the Province was in 1917 when the value reached $318,287, made up of gold, silver, and copper. With the rapid progress in development of copper-zinc and gold properties in northern Manitoba and gold properties in eastern Manitoba following the year 1930, the Province's metallic production rose from $7,209,993 in 1931 to an all-time peak of $24,744,980 in 1950.

Gold, silver, copper, zinc, cadmium, selenium, and tellurium have been extracted from Manitoba ores. Whereas the greater part of the production has come from the Flin Flon and Sherritt Gordon mines of northern Manitoba, the San Antonio gold mine at Rice Lake, together with other gold mines at Beresford Lake, Gods Lake, and Herb Lake, have made a considerable contribution to the gold and silver produced.

The Precambrian areas of Manitoba offer much that is attractive to the prospector whether for base or precious metals.

The Mines Branch of the Department of Mines and Natural Resources has a complete service bureau for prospectors, and assists in many ways in promoting the mining interests of the Province. Free assays to prospectors are made at the laboratory in Winnipeg. Prospectors' classes are held in mining communities at convenient times to give instruction in elementary geology and mineralogy, together with the identification of minerals. The Province ventured

into this work with success before the war in an attempt to provide new prospectors required for the search for minerals as the ranks of the old-time prospectors had become sadly depleted. The incidence of war compelled a relaxation in prospecting efforts for a time but the requirements of war soon proved that the search for minerals had to be maintained. Since the war it has again become evident that ore reserves can only be replaced by the finding of new reserves, for ore, unlike our forests and our grain fields, does not replenish itself. Mines deal with a wasting asset, for minerals are not inexhaustible. If the Province is to maintain a steady production of minerals, more attention than ever will have to be given to the search for new mineral deposits.

Geological reports and maps are available at the Mining Recorders' offices. Inquiries directed to the Mines Branch, Department of Mines and Natural Resources, Winnipeg, will be given prompt attention.

PART IV

GLOSSARY

A

Acid rock—Usually a light-coloured rock high in silica, soda, and potash, *e.g.*, granites, rhyolites, etc.

agglomerate—A fragmental volcanic rock.

aikinite—Lead-copper-bismuth sulphide. Soft, steel-grey mineral, easily fusible. Occurs massive and in long prismatic crystals resembling jamesonite.

albite—Sodium aluminium silicate. One of a series of minerals known as feldspars, found in acid rocks and some vein deposits.

amblygonite—A phosphate of lithium and aluminium. Massive and crystalline occurring in pegmatite dykes. Colour is usually white to pale green or blue. *Do not confuse with albite.*

amphibole—Group name of a series of minerals whose chief rock-forming member is hornblende.

andesine—A feldspar mineral, intermediate in composition between sodium-aluminium silicate and lime-aluminium silicate. Common in andesite and diorite.

andesite—Fine-grained volcanic rock intermediate in composition between acid and basic, usually green or dark grey in colour. Common constituent of "greenstone" formations.

ankerite—A carbonate of iron, calcium, and magnesium. A common gangue mineral occurring in veins with quartz, etc. Weathers, giving rusty streaks in quartz. *Do not confuse with weathered sulphide.*

anorthite—Calcium-aluminium silicate. A high calcium member of the plagioclase series of feldspar minerals.

anticline—A folded rock structure in which older rocks are enclosed by younger.

apatite—A calcium-phosphate mineral, containing chlorine or fluorine. Found in large crystals in some pegmatite dykes.

aplite—Rock term applied to fine- to medium-grained dyke rocks composed of acid feldspar and quartz. Usually light-coloured with a sugary texture.

arkose—A sedimentary rock composed principally of quartz and feldspar fragments.

arsenopyrite (mispickel)—Iron-arsenic sulphide. A steel-gray sulphide mineral. A refractory mineral occurring with many gold ores.

augite—A complex iron-magnesium-calcium-aluminium silicate. A common mineral in basic igneous rocks, especially basalts and gabbros.

B

Basalt—A dark-coloured volcanic rock. Andesite and basalt are spoken of as "greenstones" by the prospector.

basic rock—A term applied to dark-coloured igneous rocks that are low in silica, *e.g.*, basalt, gabbro, peridotite, etc.

batholith—A term applied to large irregular masses of intrusive igneous rock that have solidified at depth and have later been exposed by erosion. Usually granitic in composition.

beneficiation—A means of improving the quality of a mineral product.

beryl—A beryllium-aluminium silicate mineral. White to tints of green in colour. Occurs in pegmatite dykes. Harder than quartz and usually found in six-sided crystals.

biotite—A magnesium-iron mica. Black to dark brown. Occurs in igneous and metamorphic rocks.

bleb—A small discontinuous occurrence of a mineral within a larger mass of other mineral or rock, *e.g.*, blebs of quartz in solid sulphides.

boss—An occurrence of igneous rock of more or less circular outline and restricted areal extent with steeply-dipping contacts with the enclosing rocks.

breccia—A rock composed of angular fragments of a similar or differing composition that have been compacted or cemented together.

C

Calcareous—Term applied to rocks or minerals containing abundant lime.

calcite—Calcium carbonate. The chief constituent of limestone and a minor constituent of other sedimentary rocks. Also occurring abundantly as a gangue mineral in veins.

carbonates—A mineral group containing the acid radical CO_3. This group of minerals usually effervesces upon the application of warm hydrochloric acid. (See calcite.)

cassiterite—Tin oxide. Occurs as dark brown granular crystals in pegmatite dykes in Manitoba. Tin ore is associated with a rock type known as greisen.

chalcocite—Copper sulphide. Soft grey-black ore mineral of copper. Rare in Manitoba.

chalcopyrite—Copper-iron sulphide. Chief ore mineral of copper. Commonly associated with gold in quartz veins.

channel-sample—A sample of uniform width and depth cut across a mineral occurrence.

chert—An extremely fine-grained sedimentary rock composed largely of silica.

chlorite—A green micaceous mineral of variable composition occurring as the main constituent of greenstone schists.

chromite—Chromium iron oxide. Principal ore mineral of chromium. Occurs in intrusive rocks chiefly as dark, octahedral grains, non-magnetic, with brown streak.

cleavelandite—A lamellar variety of albite.

competency—The ability of a rock to resist forces of deformation.

conglomerate—A sedimentary rock composed of rounded water-worn fragments.

contact-metamorphic—A term referring to the alteration produced at the contact of an igneous rock with an older formation.

cubanite (chalmersite)—Copper-iron sulphide. An uncommon ore mineral of copper.

cuprite—Copper oxide. A red oxide of copper formed in the oxidized zone of ore deposits.

D

Dendritic—Branching or branch-like.

diabase—A dark-coloured dyke rock containing labradorite feldspar enclosed within augite crystals as the principal constituents.

diorite—Rock name for a medium- to coarse-grained igneous rock made up of hornblende and andesine feldspar. Occurs as small intrusive masses as compared to granite.

dip-needle—A compass having its needle swinging in a vertical plane, influenced by minor magnetic variations of differing rock types.

disseminated—Scattered or diffused through.

dolomite—Calcium-magnesium carbonate. Also a rock term denoting one composed essentially of the mineral dolomite.

drift—(1) A horizontal passage underground following the vein. (2) unconsolidated material covering the surface of the bedrock.

dyke—Tabular-shaped, intrusive, igneous rock mass which crosses structural planes of older rock. (Contrast with sill.)

E

Epidote—A green mineral containing calcium, iron, aluminium, and silica. Usually indicates some degree of rock alteration.

erosion—The process by which land areas are reduced to base-level by the agencies of water, air and ice.

esker—A narrow sinuous ridge of glacial debris deposited by a sub-glacial stream.

extrusive—Solidified on the surface of the earth, *e.g.*, lava flow. Refers to igneous rocks.

F

Fault—A break in the continuity of a body of rock attended by movement of one part of the rock-mass relative to another.

feldspathic—Containing noteworthy amounts of feldspar.

felsite—Term applied to dense, fine-grained, light-coloured igneous rocks.

flow—Term referring to the extrusive nature of volcanic rocks.

fluorite—Calcium fluoride. A colourless, green-blue, or purple mineral. In Manitoba occurs in pegmatites.

foliation—The banded or sheet-like structure of metamorphic rocks, as distinguished from the stratification or bedding-planes of sediments.

foot-wall—The wall of rock underlying a vein.

free-milling—A term applied to gold and silver ores from which gold can be recovered by crushing and amalgamation without use of chemicals or roasting. A portion of gold in an ore may be termed "free-milling."

fuchsite—A chromium-bearing mica. Green in colour.

G

Gabbro—A medium- to coarse-grained igneous rock composed mainly of labradorite feldspar, pyroxene and/or olivine. Magnetite, ilmenite and apatite also occur as accessory minerals.

galena—Lead sulphide. Chief ore of lead, commonly contains values in silver.

gangue—The valueless constituents in an orebody or vein.

garnet—A complex silicate of calcium, iron, aluminium, etc. Common in many forms of metamorphic rock. Usually has well-developed crystal form. Colour red, brown or black.

genetic—Relating to the origin of a rock type.

gneiss—A crystalline, igneous or metamorphic rock possessing a parallelism of mineral arrangement but lacking the easy cleavage of schist.

gossan—The rusty-weathered outcrop formed by the surface oxidation of a sulphide deposit.

grab sample—A sample of mineral material taken at random.

granite—A coarse- to medium-grained igneous rock, composed principally of quartz, orthoclase and acid plagioclase feldspar, with accessory minerals such as biotite, muscovite, hornblende, etc.

granitization—The process by which a rock (usually sediment) is altered so as to have the appearance and composition of a granite.

granodiorite—A coarse- to medium-grained rock, intermediate in composition between a granite and a quartz diorite.

greenstone—A general term applied to altered rocks such as andesites, basalts, etc., which have developed enough chlorite to give them a green cast.

greywacke—A sandstone derived from the erosion of a basic igneous rock.

greisen—A rock composed essentially of muscovite and quartz. Usually formed by the hydrothermal alteration of a granite.

grit –A sandstone composed of coarse angular grains and very small pebbles.

gypsum—Hydrous calcium sulphate. A soft mineral sometimes occurring in the oxidized zone of ore deposits; also as a component mineral in sedimentary beds.

H

Hanging-wall—The wall of rock overlying a vein.

hornblende—A complex iron, magnesium, calcium, aluminium silicate. Common mineral in igneous rocks, especially andesites and diorites. Alters to form chlorite.

hydrothermal—A term applied to that type of alteration produced by the action of hot mineralized waters.

I

Igneous—Referring to rocks solidified from a molten state, in constrast to sedimentary and metamorphic rocks.

ilmenite—Iron-titanium oxide. A dark, granular mineral resembling magnetite, occurring as an accessory mineral in igneous rocks or in magmatic segregations.

inclusion—A rock fragment of variable size enclosed in an igneous rock; a xenolith.

intrusive—Referring to rocks that have been introduced into older formations and which have solidified below the surface.

iron formation—Beds of sedimentary rock composed mainly of silica and considerable iron oxide as hematite or magnetite.

J

Joint—A plane or gently curved crack or fissure in a rock, with no displacement as in a fault.

K

Keewatin—Period name of early Precambrian rocks, commonly applied to lowest members of a greenstone series in the Precambrian.

L

Labradorite—Calcium-sodium-aluminium silicate. A basic member of the feldspar series.

laccolith—A mass of intrusive igneous rock which has domed overlying rocks and possesses a floor of older rocks.

lamellar—A sheeted or platy structure.

lamprophyre—A dark, sugary-textured, fine- to medium-grained dyke rock, basic in composition and commonly porphyritic.

lava—Igneous rock that has been extruded on to the earth's surface.

lepidolite—Lithium-aluminium silicate. A lilac-coloured micaceous mineral occurring in some pegmatite dykes.

limonite—Hydrous iron oxide. A rusty-coloured mineral commonly occurring in the "gossan" or weathered outcropping of an ore deposit.

lithological—Pertaining to the science of rocks.

M

Magma—Molten rock material.

magmatic segregation—A process by which certain types of ore deposit are supposed to form, due to a separation of magmatic constituents into fractional parts, *e.g.*, some deposits of chromite.

magnetite—Magnetic iron oxide. A black granular mineral. Occurs as an accessory mineral in most igneous rocks and in large deposits as the principal mineral.

metamorphic—Changed or altered. Chief agents of metamorphism in rocks are heat and pressure.

microcline—A variety of acid feldspar. Common in granite and granite pegmatites.

molybdenite—Molybdenum sulphide. A soft, foliated mineral like mica, possessing a metallic lustre.

monazite—Phosphate of the cerium metals. Thorium content gives mineral its value. Found in pegmatite dykes.

moraine—An accumulation of rock flour and boulders deposited by a glacier.

muscovite—Potash-bearing white mica. Common in igneous rock.

N

Norite—A variety of gabbro possessing a particular variety of pyroxene. A microscopic distinction.

O

Oligoclase—Sodium-calcium-aluminium silicate. A member of the feldspar series with slightly more lime than albite.

olivine—Magnesium-iron silicate. A green, granular mineral found associated with basic rocks.

orthoclase—Potassium-aluminium silicate. An acid feldspar dominant in granites.

P

Pegmatite—An extremely coarse-grained variety of igneous rock mostly granitic in composition. Occurs as dykes frequently bearing rare-element minerals.

peneplain—The lowest level to which erosion can reduce a land surface.

pentlandite—A sulphide of iron and nickel. A bronze, brittle mineral usually associated with pyrrhotite.

peridotite—An intrusive rock composed mostly of basic feldspar (labradorite) and olivine. Deposits of copper, nickel, platinum, chromium and asbestos are associated with this type of rock.

phenocryst—A large crystal in a rock surrounded by a matrix of crystals of smaller grain size.

pillow lava—Volcanic rocks possessing the rounded outline of early cooled portions of the flow incorporated in the rock mass.

plagioclase—The group name applied to a series of soda-lime-aluminium silicates known as feldspars. Common constituents of igneous rocks.

porphyry—An igneous rock in which two distinct ranges of crystal size have been developed. Not necessarily but usually fine-grained in part.

precambrian—A broad term denoting the age of rocks formed before the Cambrian period.

pyrite—Iron sulphide. A brassy yellow sulphide associated with many types of ore. Frequently intimately associated with gold.

pyroclastic—Refers to rocks containing fragments of volcanic rocks which have been ejected from volcanic vents as bombs or ash, etc. Tuffs and agglomerates.

pyroxene—Calcium-magnesium-iron silicate. A dark silicate mineral series associated with basic rocks. Augite is the common member of the series.

pyrrhotite—Magnetic sulphide of iron. A bronze-coloured sulphide mineral which is associated with many types of ore.

Q

Quartz—Oxide of silicon. A vitreous mineral, hard and without cleavage. Most common gangue mineral associated with ore deposits.

quartzite—A metamorphic rock produced by the recrystallization of quartz grains in a sandstone.

quartz porphyry—A general term used to denote a fine-grained, light-coloured dyke rock possessing quartz phenocrysts or "eyes."

R

Rhyolite—Light-coloured, fine-grained equivalent of a granite, possessing the same minerals as that rock.

S

Scheelite—Calcium tungstate. A light-coloured mineral having a high specific gravity, usually associated with high temperature deposits, veins and pegmatite dykes. Fluoresces under ultra-violet light.

schist—A metamorphic rock in which a foliated or parallel structure has been developed by recrystallization of the original rock due to shearing or pressure or both.

sedimentary—Formed by deposition in water or air.

sericite—A variety of muscovite occurring as small scales in schists.

serpentine—A hydrous magnesium silicate. A green mineral resulting from the alteration of olivine, amphibole or pyroxene.

siderite—Iron carbonate. A pale yellow to dark brown, cleavable mineral. Occurs as a gangue in many types of deposit.

silicified—Said of rock which has been impregnated with secondary, or introduced quartz.

sill—An igneous rock structure formed by the cooling of magma between bedding-planes of sediments, or between lava flows.

sinuous—Twisting, winding.

slate—A cleavable metamorphic rock produced by recrystallization of shale.

slickenside—A polished, grooved surface on a rock or vein wall formed by movement between rock masses.

sphalerite—Zinc sulphide. A pale to dark brown, cleavable mineral, occurring in many gold-quartz veins and sulphide bodies in Manitoba. Sometimes called resin-jack or black-jack.

sphene—Calcium-titanium silicate. Occurs as an accessory mineral in igneous rocks. Also known as titanite.

spodumene—Lithium-aluminium silicate. A white, platy mineral with vitreous lustre. Occurs as large crystals in some pegmatite dykes.

sporadic—irregularly occurring.

stock—An igneous mass of circular or elliptical plan outline, intrusive into older formations.

stockwork—A rock mass made up of numerous interpenetrating veinlets usually mineralized.

stratum (pl. strata)—A bed or layer of rock.

striated—Grooved or marked with a series of parallel scratches.

syenite—A coarse- to medium-grained igneous rock, composed essentially of acid feldspar and hornblende or biotite without quartz.

syncline—A folded rock structure in which younger rocks are enclosed by older.

T

Talc—Hydrous magnesium silicate. A soft soapy mineral occuring in schists and other metamorphic rocks.

tantalite-columbite—A tantalate and columbate of iron and manganese. A brownish-black mineral of high specific gravity possessing a fair cleavage. Found in bladed aggregates in pegmatite dykes.

telluride—A compound of tellurium with another element—gold, silver, lead, etc.

tetrahedrite (grey copper ore)—Copper-antimony sulphide. A massive grey-black mineral without cleavage; frequently carries values in silver.

topaz—Silicate of aluminium and fluorine. A hard, transparent mineral of variable colour, has excellent cleavage. Found associated with acid rocks—granite, rhyolite, and pegmatites.

tourmaline—A complex silicate of boron and aluminium. Mineral occurs as long slender, dark, glassy crystals, striated parallel to long axis with triangular cross-section. Found in pegmatites and contact schists and gneisses.

trachyte—Fine-grained volcanic equivalent of a syenite.

triphylite—Phosphate of iron, manganese and lithium. A glassy, greyish blue mineral possessing a good cleavage. Associated with pegmatite minerals.

tuff—A fine-grained sedimentary rock composed principally of volcanic ash.

twinned-crystals—Crystals in which one or more parts, regularly arranged, are set at fixed angles to other parts of the same crystal.

V

Varve—Variation in size of grain in the lamination of a sedimentary bed, due to seasonal changes of deposition.

vein—A more or less tabular-shaped or sheet-like mineral mass, usually composed of both ore and gangue minerals.

volcanic—Derived from volcanoes.

W

Waste-horse—A fragment of barren rock included within a vein or orebody.

Z

Zinnwaldite—Iron-lithium mica. A pale lilac to yellow-grey mineral. Occurs in pegmatite dykes.

Note—For a complete description of the minerals referred to in this glossary, the reader should consult a standard text on mineralogy.

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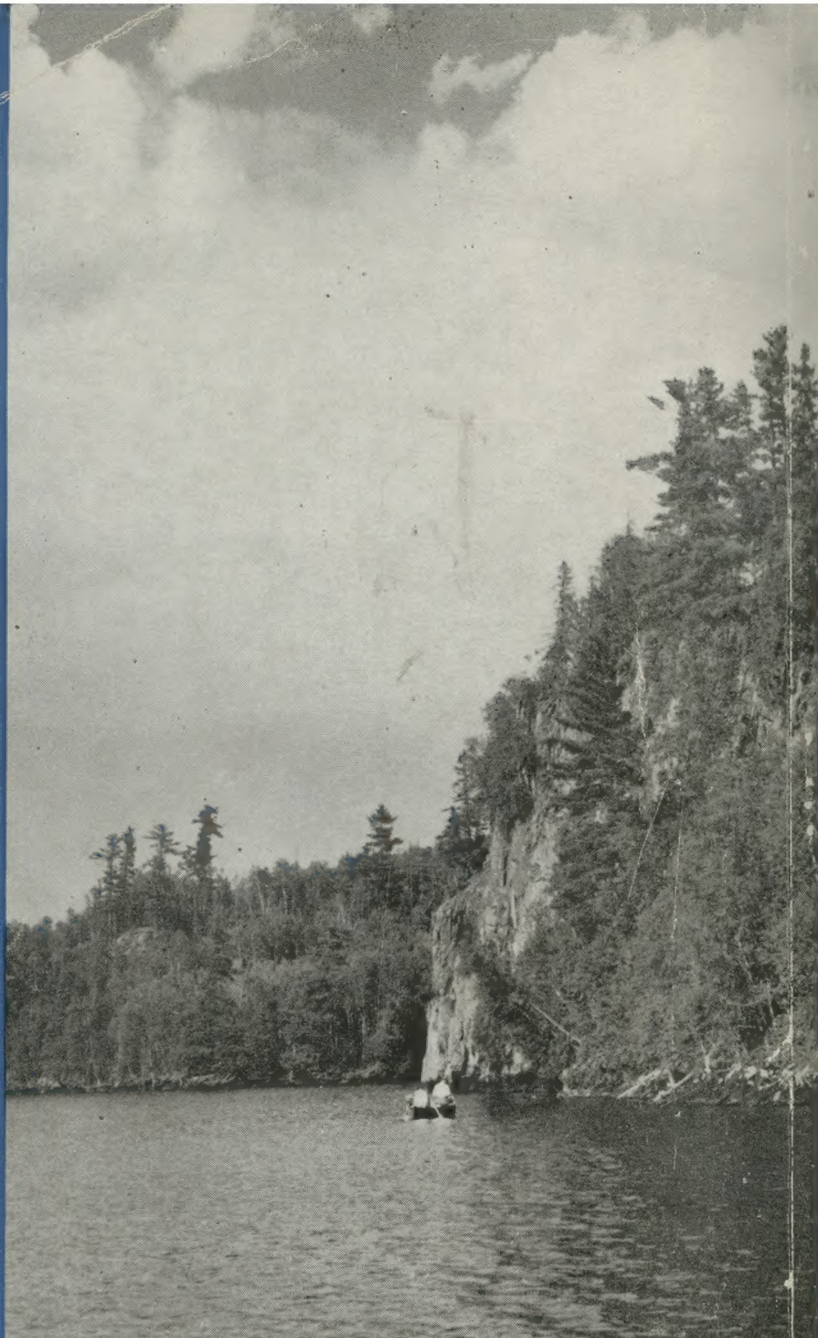

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